Zinc in the Soviet Union is produced in five plants, three employing distillation and two the electrolytic process. The latter are at Chelyabinsk, in the Urals, and at Ordzhonikidze, in the North Caucasus, respectively. Production of cathodes has been under way in the Urals since Jan. 3, 1934, and at Ordzhonikidze since early April, 1935. Points of interest in the operation of the two plants will be discussed by Julius H. Gillis in the next issue. Mr. Gillis, formerly with Anaconda at Great Falls, was in the Soviet Union for seven years, returning late in 1937.

▼

Republican Turkey, creation of Kemal Ataturk, presses the development of its mineral resources. Program and ore deposits are entrusted to Eti Bank, Government institution at Ankara, the capital (once known as Angora). "Eti," equivalent of "Hittite," recalls that ancient people of the Near East, the "first Turks" to settle in the area. Eti Bank, through "M. T. A.," organ of the Institute for Mining Investigation and Research, disseminates information regarding the country's mineral wealth. A résumé of recent achievements and the present position will appear in these pages next month.

▼

"Maden," Turkish for "mine" and an Arabic word that crept into that language (it is the "M" in M.T.A.), is the same as "Almaden," name of the commune of quicksilver fame in Spain, likewise borrowed from Arabic via the Moors. A current Spanish glossary cites "almaden" as an obsolete word meaning "mine." "Al" is Arabic for "the."

▼

Aluminum in its many applications has great appeal—no doubt about it. It catches the fancy most, perhaps, in its ability to make lighter what once was heavy and hard to move, whether for human muscles or developed power, at the same time leaving it strong for the purpose served. Herein it ranks with the electric light as a boon to mankind, long unknown while just around the corner. So it is that the *Aluminum News Letter*, published monthly by the Aluminum Company of America, shines fascinatingly among business literature of its kind, with the aid of course of capable editing.

▼

"The Industrial Bulletin," a four-page leaflet issued monthly by Arthur D. Little, Inc., chemists and engineers of Cambridge, Mass., is another bit of "business" literature that never fails to interest, in its crisp thought-provoking summaries of new developments, trends, and opportunities. Dealing usually with topics within or bordering upon the industrial field, these are occasionally less specialized, as in the one entitled "What Fools These Mowers Be," discussing various possible substitutes for grass in lawns that would greatly ease the work of maintenance.

H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

A. W. FISHER
Manager

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Vice-President

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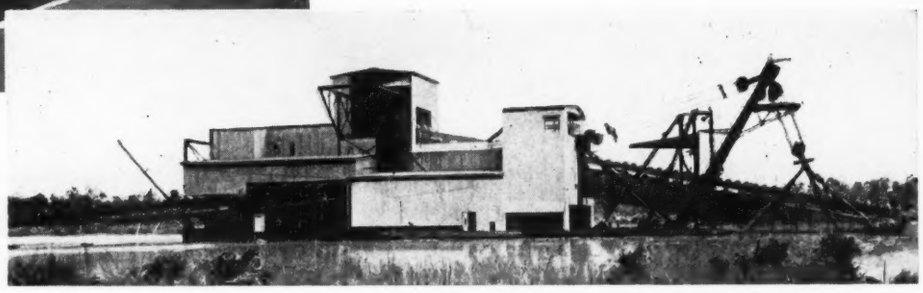
For Better DREDGING *in the* TROPICS . . .

YUBA'S PNEUMATIC CONTROL INCREASES PRODUCTION, LOWERS COST IN HOT, HUMID CLIMATES

(Above) The winchroom showing the pneumatic control.



(Right) The record making 13½ cu. ft. tin dredge, Yuba No. 86.

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APRIL, 1939

Silver Money

FEW subjects have been more controversial than silver in the world of economics in recent years. Although the early twenties, in the aftermath of the World War, witnessed some discussion when the market threatened to decline from previous satisfactory levels, the metal lost the spotlight until 1930 when the severe drop in price drove some to seek a remedy. Since then the world has been divided into three groups where silver is concerned: those who champion the metal, wanting to see something done to help its price or believing that its greater use as money has possibilities worth investigating; those who think a course of stimulation quite wrong, holding that the metal is a commodity and should be allowed to find its level in the market without artificial aid; and the rest of humanity, which likes to jingle silver coins and to buy and wear jewelry of silver but knows little about the economics of the metal and cares less.

So far as ignorance regarding silver is concerned, it has not been limited to this third group. There are aspects of the question on which few, if any, have been able to talk intelligently, although there have been lucky guesses. Much has been learned about the metal during the depression and much even yet remains uncertain. The subject has its ramifications which few have explored, and so one can still whip up an argument at a moment's notice. Helping to cloud the situation has been politics, domestic and international, so mixed with economics that it has been impossible at times to distinguish them apart. In such circumstances many will turn with interest to Dickson H. Leavens' study of the silver question, which under the title of "Silver Money" has just been presented by the Cowles Commission for Research in Economics. Facts galore on silver, enough to dispose of any question that mere facts can settle, are to be found in its 400-odd pages, wherein Mr. Leavens presents the background and development history of the use of silver as money since the beginning of the nineteenth century, dealing in the course of this with the agitation of recent years.

Facts are one thing and findings are another. Mr. Leavens' findings are sure to be unpalatable to many in the mining industry who regard silver so watchfully, especially when he says: "Silver obtained assistance for a time. This time must come to an end, and the readjustment promises to be much more painful than if the price had been allowed to reach an equilibrium without interference." As to this, in all fairness, those opposed to artificial stimuli must grant that the full story of silver is not yet written, that, in a world so disturbed and where political considerations play so large a part in determining the course of nations, the best prophecies may prove wrong.

Research into industrial uses for silver is promising, as Mr. Leavens says. He adds, however, that even at present prices, "silver costs more per ounce than most competing metals do per pound so that such uses will be limited, except where silver shows unusual superiority, unless the price drops much below the present level." Here we would remind readers once again that silver at $6 per pound avoirdupois or thereabouts is in approximately the same group marketwise as molybdenum and tungsten. So let the researcher speed his work and, dash the expense!

What will happen to silver politically in the next few months, it is impossible to forecast.

Time to Act on Strategic Minerals

SWIFTLY MOVING EVENTS in Central Europe again direct attention to the preparedness program of the United States, particularly the proposal to acquire stock piles of minerals regarded as strategic or critical by the Departments of War and Navy. Considering the grave trend of international affairs, Congress must act quickly or the country will find itself in the same emergency that confronted it twenty-odd years ago. Twenty years of study of our mineral deficiencies; twenty years of advice and counsel; twenty years of knowing what ought to be done; all may avail us nothing unless Congress acts now.

Bills have been introduced and hearings have been held by the Military Affairs Committee of

the House. At the latter a controversy developed between those who favor stock piles purely to meet an emergency and others who seek to use the plan as a means to stimulate domestic production. To us the issue seems clear cut. The crux of the matter lies not in the source of the minerals but in their quality and quantity; in short, in the specifications laid down by the agencies that will have to use the materials in the standard processes of industrial production. If domestic supplies can meet the specifications, so much the better. If not, then other sources must be tapped. The issue is wholly outside of selfish interest and it ought to be free from political maneuvers.

Those who want unbiased and expert information on the subject will find it in a "Report Upon Certain Deficient Strategic Minerals," by the staffs of the Geological Survey and the Bureau of Mines, dated Feb. 28, 1939. Prepared at the request of a Congressman, it has not yet, as far as we know, been made a part of the House hearings. It comprises an economic study of manganese, chromium, mercury, tungsten, nickel, tin and antimony. Its 40 pages are packed with facts and data, without opinion, that ought to guide Congress to an intelligent decision. Having asked its technical bureaus for information, will Congress accept or ignore it, regardless of its implications? Shall we have mineral stock piles for military purposes, or for political expediency? We see no reason to depart from the convictions expressed in these columns last January. The emergency should be met honestly. In the meantime all reasonable aid should be extended to the development of promising prospects of domestic supply.

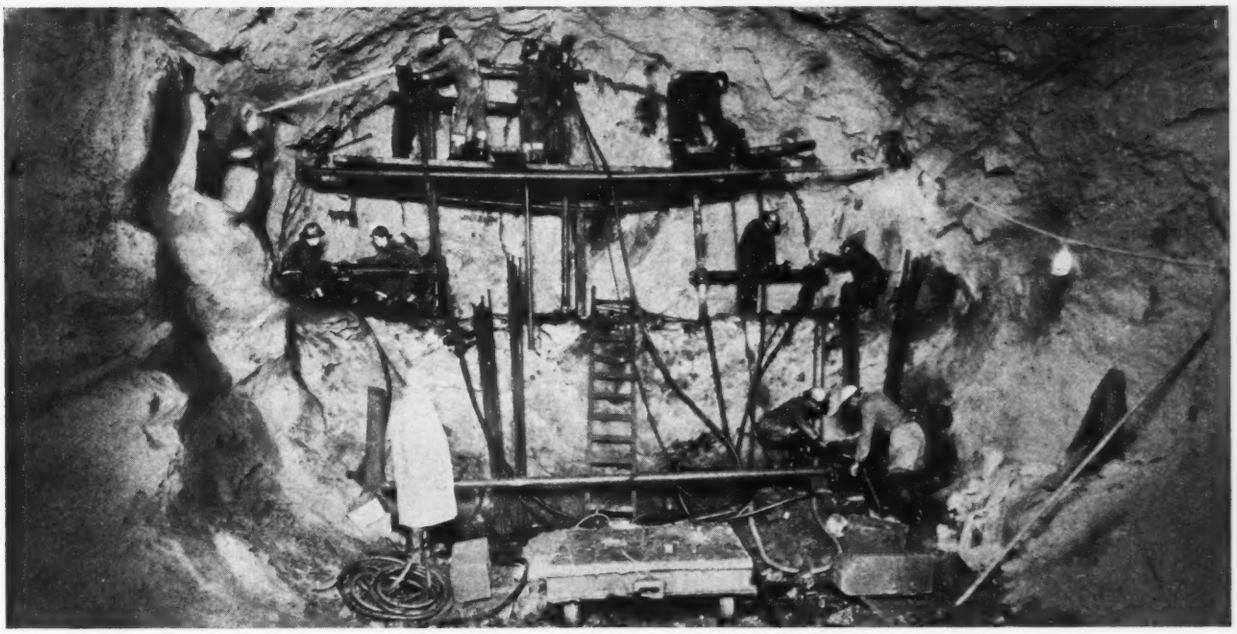
Risk in Suspension

TO THE LONG LIST of arguments against further suspension of the legal requirements as to assessment work on mining claims, all of which are so familiar that they have almost lost their force, we add one by way of warning. Continued exemption constitutes an abuse of a privilege granted during an emergency. It also constitutes an abuse of our system of public land administration that permits free entry and location of mining claims based on mineral discovery. That system, however, has its enemies who would abolish it, reserve title to mineral lands in the name of all the people, and permit exploitation only by leasing from the federal Government. And enemies of any system seize quickly on abuses of the existing order as prima facie evidence that it should be changed. So if we wish to preserve our system of mineral land location it must be kept free from abuse and made to work simply and honestly. We hope the present Congress will refuse to extend exemption of annual assessment work on unpatented mining claims and thus bring abuse to an end.

Expropriation and Conversations

MARCH 18, anniversary of the petroleum expropriation in Mexico, found the Government of that country still in possession of the seized properties, with seemingly little being done to rectify the matter, aside from leisurely conversations between Washington and Mexico City that have yet to demonstrate their effectiveness. The historic day, contemplation of which has been so stimulating to the patriotic fervor of the masses south of the Rio Grande, also found ignorance rather widespread in the United States as to the net effect of the expropriation in terms of petroleum output. For whatever reason, there is confusion of ideas as to the share of the industry's total output before expropriation that was contributed by the properties subsequently expropriated, a matter that still seems hard to clarify despite efforts in that direction; and, at the same time, many appear to think that petroleum activities in Mexico have been largely paralyzed by expropriation, with evil consequences for Government and people, so that news of shipments from time to time is occasion for surprise.

The fact is that, despite unquestioned embarrassment in official and financial circles resulting from the seizure, actual petroleum production in the Republic in 1938 was in the neighborhood of 36,000,000 bbl. compared with 47,000,000 bbl. the year before, a material drop indeed but one falling far short of expectations aroused by news reports. Just how and where this output was won is not material at the moment, likewise the declaration in certain quarters that, but for the seizure, production would have greatly exceeded that of 1937. The figures speak for themselves—expropriation is not collapsing from its attendant difficulties. In Washington apparently rests the only hope of American companies that suffered seizure of their properties. Wider appreciation by the public of the actual situation should help speed disposal of the question. In opposing the expropriation, this Government is championing the cause not only of the American oil companies in Mexico but of American investors abroad in general, among whom none are less important than this country's mining interests. Greater evidence of its zeal for this cause would be welcome in many quarters.



Largest underground project now under way in New York State involving a dust hazard is the Delaware Aqueduct, 85 miles long

Wet Drilling Conditions Specified for New York State

Board of Standards and Appeals approves rock drills that meet code set to combat silicosis

H. C. Chellson
Assistant Editor

APPROACHING the problem of eliminating the dust hazard in rock drilling in as rational and common sense a manner as possible, New York State has pioneered in this country in setting up standards developed from its investigations. The results set forth ratios between amount of air and water that passes through the hollow drill steel and amount of dust produced, together with volume of ventilation required for non-hazardous drill operation. Table I shows these established ratios.

Expert opinion on the problem was drawn from members of the medical and engineering professions together with facts established over long years of study by mine operators in South Africa. Reduced to terms of a so-called code, these standards have as their fundamental basis the use of rock drills with which the operator cannot drill unless water accompanies the operation independently of the air pressure used to drive the drill. Therefore, steady progress is being made by the Industrial Board[1] of New York State in its campaign to combat silicosis. Events that have led to this desire are the so-called silicosis racket, 85 miles of underground tunneling for the Delaware Aqueduct, subway construction, mining, and quarrying. The Board of Standards and Appeals has placed rock drills under test, and more than 80 have met the standards, so far, for wet drilling. This has attracted broad interest not only in the rock-drilling field but in various State Legislatures now studying problems involving dust hazards. Thus, drill operators in New York State are restrained from collaring a hole dry, a practise that drillers in many metal mines still follow, much against their welfare. Tests in South Africa have shown that the volume of dust produced in collaring a hole (to a depth of several inches) averages about 7 to 1 against drilling the remainder of the hole. The United States Bureau of Mines has pointed out that wet drilling in many cases is a misnomer because many drill operators only partially turn on their water valves, but the air valve is turned on full, virtually creating an air blast through the drill hole and scattering moist rock dust from the hole into the air.

In the extensive report on "The Prevention of Silicosis on the Mines of the Witwatersrand," issued early in 1938, there appeared the following conclusion:

"Drilling dust appears to rise from two sources—(a) dust made at the bit during the passage of air bubbles make their way down the bore of the steel and which carry dust in suspension up through the sludge to the atmosphere; (b) the rubbing of the jumper stem (drill steel) in the barrel of the hole at or near the collar under insufficiently wet conditions; the amount of dust made in this manner is small and represents only a substantial proportion of the total drilling dust made when the dust derived from air bubbles has been virtually eliminated. Factor (a) can to a large extent be controlled by employing release ports and a short water tube of maximum bore; (b) will be checked by the use of this tube owing to its effect in increasing the amount of sludge flowing out of the hole."

[1] Code authority formerly exercised by the Industrial Board was transferred to the State Board of Standards and Appeals created in the Department of Labor by Chapter 819 of the Laws of 1937.

Metal-mining companies have cooperated with the Bureau of Mines, and today the silica dust has been reduced to safe limits through the practice of wet-drilling water sprays, and data continue to be accumulated by mining engineers on mine ventilation and air conditioning; and with the growing cooperative attitude of miners in heeding all types of safety education, the dust hazard in metal mines is approaching a minimum. The mining industry is, however, interested in learning what procedure the State Board of Standards and Appeals has been following, and the data herewith presented are interesting records for the industry.

Silica bearing rock was classified as follows:

1—"Any rock formation of substantially uniform geological character having free silicon dioxide as a component part which is known from geological studies or otherwise can be shown by the applicant (rock drilling employer) to the satisfaction of the Industrial Commissioner, to run uniformly less than ten (10) per cent by weight of the rock formation.

2—"All rock formations having free silica dioxide as a component part, ten (10 per cent or more by weight, and all other formations, natural and synthetic, having a variable and unpredictable content of free silicon dioxide."

The rules define "injurious silica dust concentration" as dust produced from drilling silica-bearing rock which is in excess of the following values as determined by an approved dust count method:

Table I—Standards for General Ventilation in Confined Areas, Using Drifter-mounted and Wagon-mounted Drills (Maximum Piston Bore 4 In.)

Class of Drill	Limitations in Air and Water Flow Through Steel: Air Flow	Water Flow	Full-speed Operation Air, c.f.m.	Full-speed Operation Water, g.p.m.	Half-speed Operation Air	Half-speed Operation Water, g.p.m.	Ventilation (a)
I	High	Low	4–6	0.5–0.75	5–12	0.5–0.75	2500
II	Medium	Medium	2–4	0.75–1.5	2–5	0.75–1.5	2000
III	Low	High	0–2	1.5 & over	0–2	1.5 & over	1200

(a) Minimum rate of ventilation for one drill—cubic feet per minute.

Table II—Mechanical Ventilation Requirements for Wet Drilling

Drills Approved — Condition 1

Open Areas, Class I or II rock, without additional mechanical ventilation.
All drills listed in Table III may be used under above working conditions.

Drills Approved — Condition 2

Confined Areas, Class I rock without additional ventilation.
All drills listed in Table III may be used under above working conditions.

Drills Approved — Condition 3

Class I Drifter Drills (High Air Flow and Low Water Flow — Table I)

Confined Areas, Class II rock with a minimum of 2,500 c.f.m. additional mechanical ventilation at the working area.

Cleveland Rock Drill Company	Automatic drifter AD–12.
Ingersoll-Rand Company	Drifter N–75.

Class II Drifter Drills (Medium Air Flow and Medium Water Flow — Table I)

Confined Areas, Class II rock with a minimum of 2,000 c.f.m. additional mechanical ventilation at the working area.

Cleveland Rock Drill Co	Automatic drifters AD–77.
" " " "	Drifters D–12; D–14; D–77.
" " " "	Wagon drill rigs D–14DR; D–12DR.
" " " "	Drifter on wagon D–14WD; D–12WD.
Gardner-Denver Co	Drifter 17L(2).
Independent Pneumatic Tool Co	" 38A; 39A.

Class III Drifter Drills (Low Air Flow and High Water Flow — Table I)

Confined Areas, Class II rock, with a minimum of 1,200 c.f.m. additional mechanical ventilation at the working area.

Chicago Pneumatic Tool Company	Drifters CP–60; CP–70; CP–50.
Cleveland Rock Drill Company	Automatic drifters AD–12; AD–77.
" " " "	Drifters D–14; D–77; D–12.
" " " "	Drifter wagon drills D–12WD; D–14WD.
" " " "	" " drill rig D–14DR; D–12DR.
Gardner Denver Company	Drifters 17L (1), D–89–B; D–79; D–99.
" " "	Automatic drifters, AF–89; AF–79, AF–79.
Independent Pneumatic Tool Co	Drifters 90A; 70A; 75A; 72A.
Ingersoll-Rand Company	" S–70; DA–30; N–75; L–74; DA–35.
Sullivan Machinery Company	" L–9; T–11; T–9; L–12; L–11; L–2; T–10.
Worthington Pump & Machinery Co	" No. 169; 180.

Hand Held Drills (3)

Confined Areas, Class II rock, with a minimum of 500 c.f.m. additional mechanical ventilation at the working area.

Chicago Pneumatic Tool Company	Hand-held sinker	CP–32W; CP–42W; CP–52W; CP–22W.
Cleveland Rock Drill Company	" "	H–10; H–77; H–11.
Gardner Denver Company	" "	S–79; S–45; S–55.
Independent Pneumatic Tool Co	" "	39A auger; 72A; 70A; 75A.
" " "	" "	38A.
Ingersoll-Rand Company	Hand-held sinker	S–49; S–68; X–59; JA–55; JA–45.
Sullivan Machinery Company	" "	L–9; H–2; L–11; L–2; L–1; L–12.
Worthington Pump & Machinery Co	" "	No. 175.

(1) Two vent holes open in chuck. (2) All vents plugged in chuck. (3) Hand-held drills (maximum piston bore 3 in.; minimum rate of water flow through the drill steel is 0.75 g.p.m.) except in Class II rock confined areas, in which case the permissible air flow through the drill steel at full speed shall be 2 cu.ft. (maximum) and the required water flow shall be 0.75 g.p.m. (minimum); at half speed the air flow shall be 1 cu.ft. (maximum) and the water flow 0.75 g.p.m. (minimum)

All rock-drilling operations must be executed so that there will be no dissemination of injurious silica dust concentration into the atmosphere. Dust control may be effected by suction or exhaust, and wet methods when approved by the Industrial Board, and other methods which may be invented or developed in the future, providing they are approved by the Board.

These classifications were also applicable to dry drilling, and equipment approved for this was described in *Engineering and Mining Journal*, April, 1938. Standards for wet drilling, however, came after those of dry drilling, after much study by the State Board of Standards and Appeals. These standards were described more fully in *Engineering and Mining Journal* of July, 1938. A brief summary at this time, however, is given.

Dust control by the "Wet method" shall mean the use of wet drilling and necessary ventilation and shall mean the continuous application of water though the central hole in the hollow drill steel to the bottom of the drill hole. The central hole in the steel shall not be less than 3/16-in diameter. The water flow shall be maintained continuously whenever the drill is in operation, including the period of collaring or starting the drill hole. The valve in the water line shall be of such design that it has only two fixed positions—namely, closed and completely open. Wet drilling in Class 1 rock (100,000,000 particles per cubic foot of air) in open or confined areas without the use of mechanical ventilation was approved for hand-held drills (maximum piston bore 3 in.) providing minimum rate of water flow through the drill steel is 0.75 g.p.m. For drifter-mounted and wagon-mounted drills (maximum piston bore 4 in.) the minimum rate of water flow through the drill steel is 15 g.p.m. In wet drilling in Class 2 rock (10,000,000 particles per cubic foot of air) in confined areas, there must be mechanical ventilation, or in confined areas under decking by natural ventilation, if approved by the Industrial Commissioner and subject to the provision, that the rock surfaces for a distance of 30 ft. from the heading or other drilling area shall be maintained in a damp condition.

On the subject of ventilation the standards state that in case positive pressure ventilation is used, the air must be distributed over the drilling area and the intake for the ventilation system must be located at a point free from contamination with dust, or provided with an efficient filter. If exhaust ventilation is employed, the intake pipe or pipes must insure the removal of air from the entire drilling area. The required ventilation may be obtained by means of a recirculating air-cleaning apparatus provided the dust concentration in the air at the breathing zone of the drill operator is maintained at a level below the required dust count.

Drill manufacturers studied the standards for wet drilling and made some changes in design to meet the requirements and submitted drills for testing that was done at their respective plants under the direction of representatives of the State Board of Standards and Appeals. Specifications of water tubes and other important di-

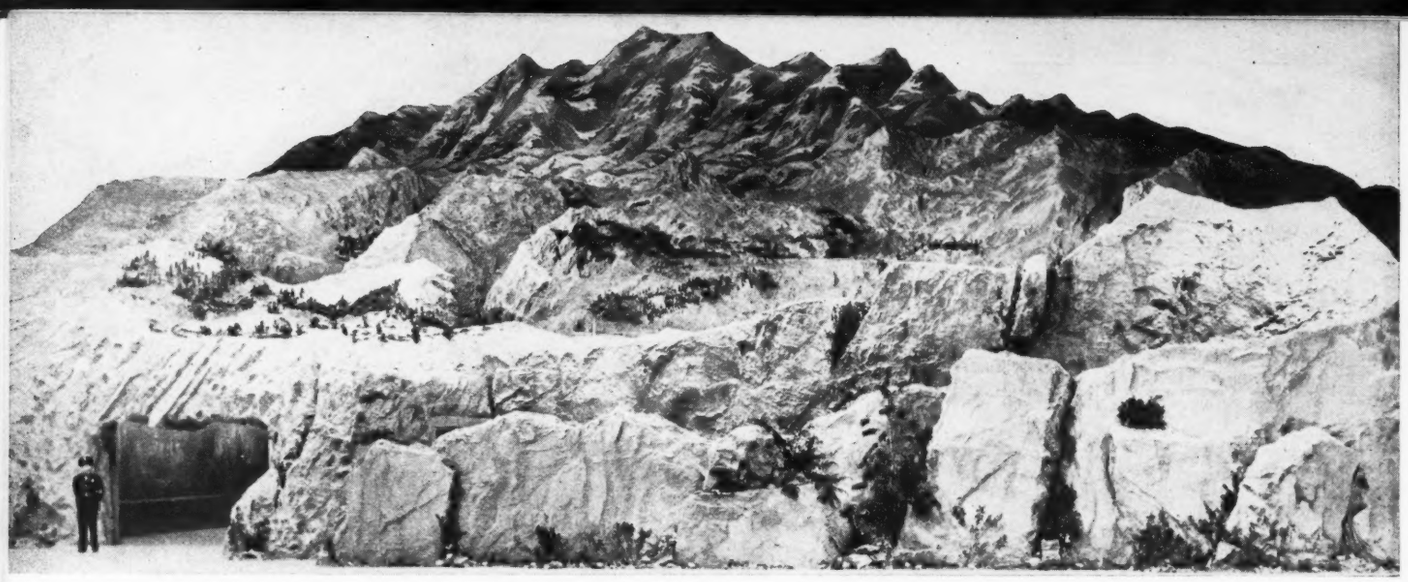
Table III—Important Dimensions of Approved Rock Drills Used for Wet Drilling in New York State

Note—These drills satisfy code requirements for air and water supply under Table I. Actual dust count, however, is checked by State inspectors who visit the various drilling operations.

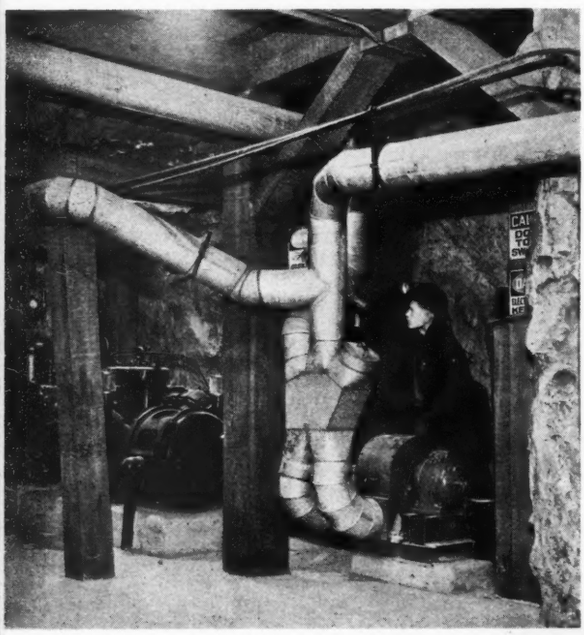
TYPE	Model No.	Piston Diameter (Inches)	Size of Water Ports in Tube Plug	Water-Tube Dimensions (Inches)						Penetration into Drill Steel (Inches)	Water-Tube and Piston Clearance (Inches)	Clearance at Piston Stem (Inches)	New York State Approval No. B.S.A.	Mode No.
				Length	Large O.D.	Small O.D.	Large I.D.	Small I.D.	Swage Length					
Chicago Pneumatic Tool Company, Detroit, Mich. [4]														
Drifter	CP-60	3½	1 hole ¼-in. dia.	17¼	¼	¼	1/2	1/2	1/2	½ to 1	0.007–.015	0.0025–0.0035	2338	CP-60
Drifter	CP-70	4		19 1/16	0.3125	0.219	¼	1/2	1 1/16	"	"	"	"	CP-70
Hand-held sinker	CP-32W	2⅝	1 hole 11/32-in. dia.	13⅝	¼	1/2	1/2	1/2	3⅝	"	"	0.0015–0.003	"	CP-32W
" "	CP-42W	"		15 1/16	"	½	1/2	1/2	...	½ to 1	"	"	"	CP-42W
" "	CP-52W	3	1 hole 1/2-in. dia.	17	¼	¼	1/2	1/2	...	"	"	0.002 –0.0035	"	CP-52W
Drifter	CP-50	"	1 hole ¼-in. dia.	16 1/2	"	"	1/2	1/2	1/2	"	"	"	"	CP-50
Hand-held sinker	CP-22W	2⅜	1 hole 11/32-in. dia.	11 1/16	"	"	1/2	1/2	...	"	0.002–.010	0.0015–0.003	"	CP-22W
Cleveland Rock Drill Company, Cleveland, Ohio [4]														
Automatic drifter	AD-12	3½	2 holes 1/2-in. dia.	23¾	¼	0.225	1/2	1/2	3¾	½	0.0075	0.00075	2339	AD-12
" "	AD-77	3⅛	"	22	"	"	"	"	5⅜	"	"	"	"	AD-77
" "	AD-12	3½	"	23¾	"	1/2	"	1/2	1/2	"	"	"	"	AD-12
" "	AD-77	3⅛	"	22	"	"	"	"	"	"	"	"	"	AD-77
Drifter	D-12	3½	"	21½	"	0.225	"	1/2	6⅝	"	"	"	"	D-12
"	D-14	3½	"	19 1/2	1/2	"	1/2	"	2	"	0.009	"	"	D-14
"	D-77	3⅛	"	19¾	¼	"	1/2	1/2	8⅛	"	0.0075	"	"	D-77
"	D-14	3½	"	19 1/2	1/2	¼	1/2	1/2	2	"	0.009	"	"	D-14
"	D-77	3⅛	"	17	¼	1/2	1/2	1/2	1/2	"	0.0075	"	"	D-77
"	D-12	3½	"	16⅝	¼	"	"	"	"	"	"	"	"	D-12
Hand-held sinker	H-10	2⅝	"	14⅝	¼	0.225	1/2	1/2	1⅜	"	"	"	"	H-10
" "	H-77	"	"	"	"	"	"	"	"	"	"	"	"	H-77
" "	H-11	"	"	15⅝	"	"	"	"	2⅜	"	"	"	"	H-11
Wagon drill	D-12WD	3½	1 hole ¼-in. dia.	18⅝	1/2	¼	1/2	1/2	1 1/16	"	0.009	"	"	D-12WD
Drifter on drill rig	D-14DR	3½	1 hole 1/2-in. dia.	19 1/16	1/16	0.225	1/16	1/2	2	"	"	"	"	D-14DR
Drif. on wagon drill	D-14WD	"	1 hole ¼-in. dia.	"	1/16	"	"	"	"	"	"	"	"	D-14WD
Drifter on drill rig	D-14DR	"	"	"	"	¼	"	1/2	2	"	"	"	"	D-14DR
" " "	D-12DR	"	"	18⅝	"	0.225	"	1/2	1 1/16	"	"	"	"	D-12DR
Drif. on wagon drill	D-12WD	"	"	"	"	"	"	"	"	"	"	"	"	D-12WD
Drifter on drill rig	D-12DR	"	"	"	"	¼	"	1/2	"	"	"	"	"	D-12DR
Wagon drill	D-14WD	"	"	19 1/16	"	"	"	1/2	2	"	"	"	"	D-14WD
Gardner Denver Company, Quincy, Ill. [4]														
Drifter	D-79 [1]	3	2 holes 1/32x1/32-in. dia.	16⅜	0.315	0.245	1/2	1/2	4¼	None	0.008–0.013	0.00475–0.00575	2340	D-79
"	D-79 [2]	"		"	"	"	"	"	"	"	"	"	"	D-79
Automatic drifter	AF-89	3½	"	25 11/16	"	0.218	"	"	1 1/16	"	"	0.0035 –0.0045	"	AF-89
" "	D-89B	"	"	18 3/16	0.328	0.248	"	"	"	"	0.003–0.008	"	"	D-89B
" "	AF-99	4	"	27 1/16	0.326	0.245	"	"	1 1/16	"	"	0.004 –0.005	"	AF-99
Hand-held sinker	S-79	3	"	16⅝	0.315	0.245	"	"	4¼	"	0.008–0.013	0.003 –0.0045	"	S-79
"	S-45	2⅝	"	12 1/16	"	0.212	"	1/2	3 1/16	"	"	0.003 –0.004	"	S-45
Drifter	D-79	3	"	16⅝	"	0.245	"	1/2	4¼	"	"	0.003 –0.0045	"	D-79
Automatic drifter	AF-79	3	"	23 11/16	"	"	"	1/2	4 1/16	"	"	"	"	AF-79
Drifter	D-99	4	"	19 1/16	0.326	"	"	"	1	"	0.003–0.008	0.004 –0.005	"	D-99
Hand-held sinker	S-55	2⅝	"	14⅛	0.315	0.215	"	1/4	3⅜	"	0.008–0.013	0.002 –0.003	"	S-55
Independent Pneumatic Tool Company, Chicago, Ill. [4]														
Hand-held sinker (Auger)	39A	2⅝	4 holes 1/16-in. dia.	15⅝	0.249	...	0.180	...	...	½	0.001	0.0015	2341	39A
Drifter	38A	"	"	"	"	"	"	...	...	1½	"	"	"	38A
Hand-held sinker	72A	"	"	17¼	"	...	"	...	...	"	"	"	"	72A
" "	70A	"	"	"	"	...	"	...	...	"	"	"	"	70A
Drifter	39A	"	"	15⅝	"	...	"	...	...	"	"	"	"	39A
Hand-held sinker	38A	"	"	"	"	...	"	...	...	"	"	"	"	38A
Drifter	90A	3½	2 holes ¼x1/32-in. dia.	21 11/16	0.3115	...	0.213	...	...	1½	"	"	"	90A
"	70A	2⅝	4 holes 1/16-in. dia.	17¼	0.249	...	0.180	...	...	"	"	"	"	70A
Hand-held sinker	75A	2⅝	"	"	"	...	"	...	...	"	"	"	"	75A
Drifter	75A	"	"	"	"	...	"	...	...	"	"	"	"	75A
"	72A	"	"	"	"	...	"	...	...	"	"	"	"	72A
Ingersoll-Rand Company, New York, N. Y. [4]														
Drifter	S-70	4	3 holes 1/8-in. dia.	20 1/16	0.305	11/32	0.206	1/4	3 1/16	1⅝	0.015	0.0045	2342	S-70
"	DA-30	3		19 1/16	0.312	"	"	"	6⅝	"	0.008	0.0035	"	DA-30
Hand-held sinker	S-49	2⅝	5 holes 0.086-in. dia.	15¼	0.260	11/32	0.159	1/4	3⅜	1 1/16	0.019	0.0035	"	S-49
" "	S-68	"	4 holes 1/16-in. dia.	15 11/16	0.253	"	0.153	"	3½	"	0.009	0.0045	"	S-68
" "	X-59	3	3 holes 1/16-in. dia.	16½	0.312	11/32	0.206	1/4	3⅝	1⅜	0.008	0.0045	"	X-59
Drifter	N-75	3½	3 holes 1/16-in. dia.	18 1/16	0.305	11/32	0.206	1/4	2 1/16	1⅝	0.015	0.004	"	N-75
"	L-74	3	3 holes 1/16-in. dia.	16½	0.312	"	"	"	3⅝	1⅜	0.008	0.0045	"	L-74
Hand-held sinker	JA-55	2⅝	5 holes 0.086-in. dia.	16 1/16	0.250	11/32	0.153	1/4	3 1/16	"	0.006	0.0035	"	JA-55
Drifter	N-75	3½	3 holes 1/16-in. dia.	18 1/16	0.305	11/32	0.206	1/4	...	1⅝	0.015	0.004	"	N-75
Hand-held sinker	JA-45	2½	5 holes 0.086-in. dia.	15 11/16	0.255	"	0.153	1/4	2½	"	0.013	0.0035	"	JA-45
Drifter	DA-35	3½	3 holes 1/8-in. dia.	20 1/16	0.312	11/32	0.206	1/4	...	1 1/16	0.008	0.0035	"	DA-35
Sullivan Machinery Company, Claremont, N. H. [4]														
Hand-held sinker	L-9	2¾	4 holes 1/32-in. dia.	14½	¼	7/32	1/2	1/2	1½	¾	0.125 –0.0155	0.00075–0.00175	2343	L-9
" "	H-2	2⅝	"	12 11/16	"	11/32	1/2	"	1⅞	"	0.015 –0.023	0.00125–0.002	"	H-2
" "	L-11	3	2 holes 1/16-in. dia.	17 1/16	"	"	"	"	3½	¼ short	0.0125–0.0155	0.0015 –0.00225	"	L-11
" "	L-2	2⅝	4 holes 1/32-in. dia.	13¾	"	"	0.134	"	1⅞	5/8	0.015 –0.023	0.00075–0.00175	"	L-2
" "	L-1	2¼	"	11¾	"	"	1/2	"	"	"	"	"	"	L-1
Drifter	L-9	2¾	"	13½	"	...	1/2	...	...	⅛ short	0.0125–0.0155	"	"	L-9
"	T-11	3	2 holes 1/16x1/16-in. dia.	16 1/16	"	...	"	...	...	" "	0.015 –0.023	0.0015–0.00225	"	T-11
"	T-9	4	"	18½	"	...	"	...	...	" "	0.0125–0.0155	"	"	T-9
"	L-12	2⅞	"	15 1/16	"	...	"	...	...	" "	0.015 –0.023	0.00075–0.00175	"	L-12
"	L-11	3	"	17 1/16	"	...	"	...	...	" "	0.0125–0.0155	0.0015 –0.00225	"	L-11
"	L-2	2⅝	4 holes 1/32-in. dia.	12 11/16	"	...	"	...	...	" "	0.015 –0.023	0.00075–0.00175	"	L-2
"	T-10	3½	2 holes 1/16x1/16-in. dia.	18 1/16	"	...	"	...	...	" "	0.0015–0.00225	0.0125 –0.0155	"	T-10
Hand-held sinker	L-12	2⅞	2 holes 1/16-in. dia.	16⅜	"	11/32	1/2	1/4	2⅜	⅞	0.015 –0.023	0.00075–0.00175	"	L-12
Worthington Pump & Machinery Corporation, Harrison, N. J. [5]														
Drifter	No. 169 [3]	3	Straight through conn.	16¾	0.248	1/16	1/8	1/8	3¼	1¼	0.002–0.003	0.0025–0.0035	2344	No. 169
"	No. 180 [3]	3½	" " "	"	"	"	"	"	"	"	"	0.003 –0.004	"	No. 180
Hand-held sinker	No. 175 [3]	3	" " "	"	"	"	"	"	"	"	"	0.0025–0.0035	"	No. 175

[1] All vents plugged in chuck.
[2] Two vent holes open in chuck.
[3] Adaptor and chuck sleeve clearance — 0.004–0.0055 in.
[4] All drills of manufacturer listed herewith have an internal rotating mechanism, maximum operating air pressure of 100 lb. per sq. in., and 40 lb. per sq. in. minimum operating water pressure.
[5] All drills of manufacturer listed herewith have an external air motor; maximum operating air pressure of 110 lb. per sq. in., and 40 lb. per sq. in. minimum operating water pressure.

mensions in the various drills approved for use in wet drilling in New York State are given in Table III. Non-hazard limits in wet drilling were determined (see Table I) on a per-drill basis when drilling in specified classes of silica rock provided a specified volume of natural or mechanical ventilation is provided at the working face. The minimum volume of ventilation required per drill, (drifter-mounted and wagon-mounted drills), per cubic foot per minute is shown in Table II. After March 1, 1939, all approved wet drills will be equipped with a combination air throttle and water valve of such design that the required rate of water flow through the drill steel will be insured whenever the air throttle is in the operating positions half speed as well as full speed."



Treasure Mountain, a bit of the world of mining, in the Hall of Mines, Metals and Machinery. Sixty feet high and 160 x 86 ft. in plan, its interior conceals full-scale reproductions of mine workings, through which the visitor may walk; also dioramas and murals telling the story of metals in serving man. On its slopes models depict surface mining of various sorts



Blower and air compressor near the shaft station

San Francisco's Fair

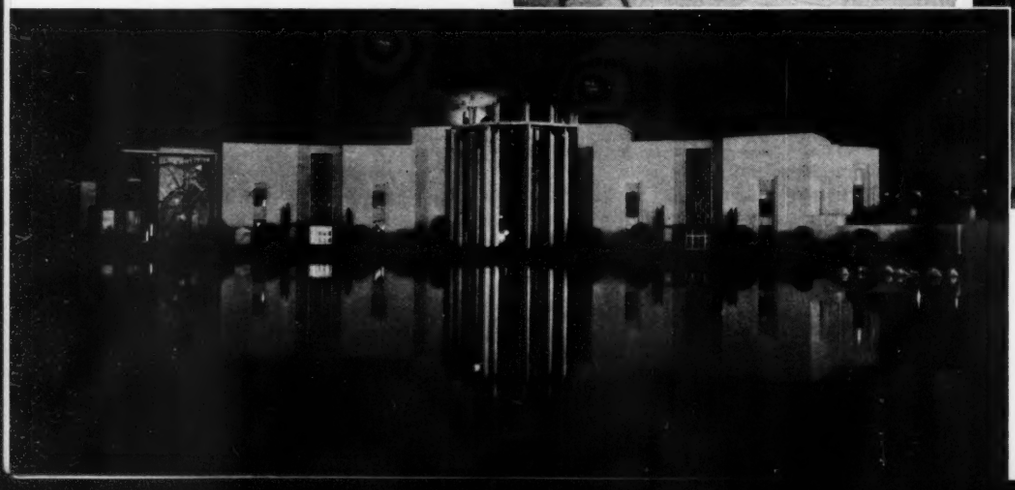
NATURE and the designer have provided a most beautiful setting for the exhibits of the Golden Gate International Exposition, on Treasure Island, in San Francisco Bay, which got under way at the appointed time on Feb. 18. The theme of the exposition is recreation. The well-planned exhibit housed in buildings of the new "Pacific" style radiating from the 400-ft. Tower of the Sun show how industry in the field of electricity, transport, petroleum, and mining has increased the time for leisure and added to the possibility of enjoying it.

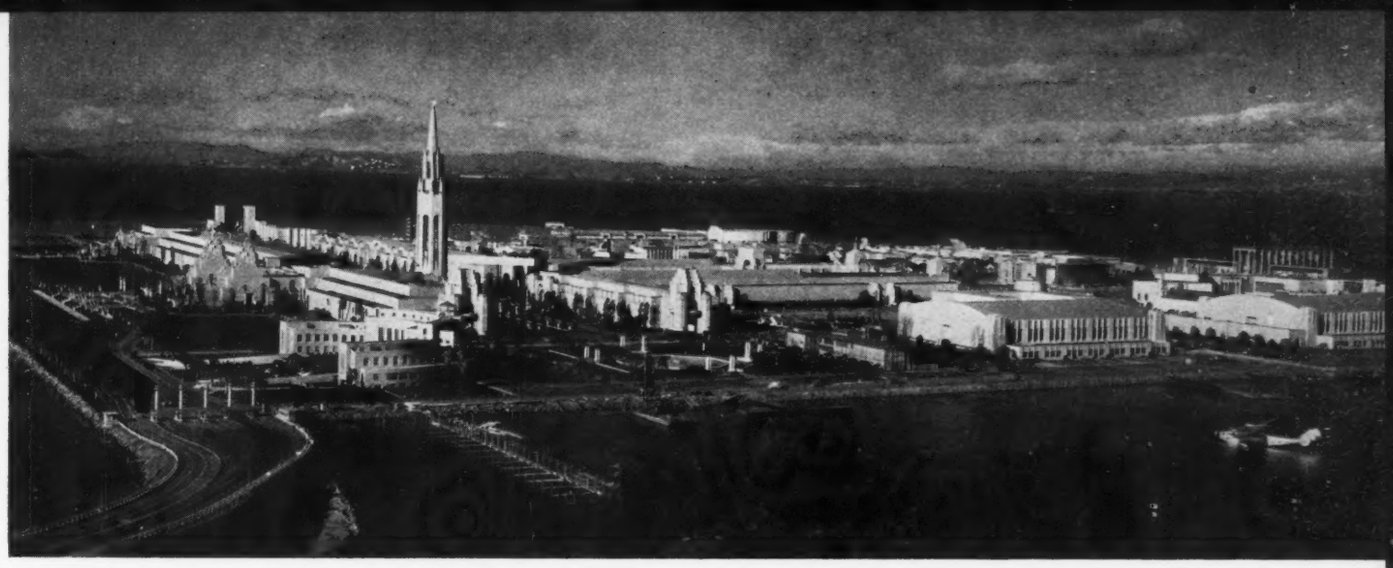
Of major interest in the Hall of Mines, Metals, and Machinery is Treasure Mountain, intended to bring the story of mining to the public. Conceived and brought into being by Mining Exhibits, Inc., a non-profit organization headed by B. C. Austin, consulting

Drifts opening from the station

A shaft station underground in Treasure Mountain

California is well represented at the Fair. Here are its State Building and its San Francisco Building, left and right respectively, flanking the California Colonnade. Looking across one of the Lakes of the Nations





Treasure Island from the heights of Yerba Buena Island, close by

Takes Note of Mining

mining engineer of San Francisco, it covers an area of 86x160 ft. On its sloping side are scale models depicting dredging, open-pit mining, hydraulicking, and saline and oil development. Ascending a gently sloping way, one enters the upper portion of the mountain given over to underground mining. Here are full-size reproductions of development drifts, a section of a coal seam, a square-set stope, an open stope, an underground drill-sharpening shop, an explosive storage and preparation chamber, and a three-compartment shaft, all equipped. In the lower portion the story of man and metals is told by dioramas and murals, the latter by Irwin D. Hoffman. Electrically operated maps give metal and mineral production figures. A display of metals and mineral specimens and old mining relics round the story. A small part of the whole is shown here.

The Palace of Mines, Minerals, and Machinery on the left and, on the right, the Tower of the Sun

Placer and open-cut mining—a mural by Irwin D. Hoffman

Fire-setting, the ancient method of breaking rock underground. From another mural by Irwin D. Hoffman

Dollars in Current Tailings of Mesabi Washing Plants

An estimate of profits now lost in cases where the use of flotation might increase recovery

T. B. Counselman
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Chicago, Ill.

A RECORD of laboratory results obtained on three samples of Mesabi wash-ore tailing, as the outcome of several years of experimental work, was presented by John N. Searles in an article published in the *Engineering and Mining Journal* of June, 1938, under the title "Some Tests With Flotation on Mesabi Wash-ore Tailings." The purpose of the present paper is to translate these experimental results into an economic analysis of what they would mean to the iron ore operator, and to point out some details of the commercial application of this operation.

For convenience, this analysis is based on the same three samples cited in Professor Searles' paper. Table I recapitulates the results which he reported.

Table I—Results of Laboratory Work

Samples	A	B	D
Analysis of original tailing, % Fe..	23.84	19.29	21.76
Per cent loss in weight by desliming.	55.29	71.26	26.40
Analysis of deslimed material % Fe.	29.83	27.83	23.75
Weight recovery by flotation.....	40.69	31.28	28.69
Over-all weight recovery.....	18.20	8.98	21.12
Analysis of flotation concentrate,			
% Fe.....	61.02	58.81	63.44
% SiO_2.....	8.84	9.52	5.71
Analysis of flotation tailing, % Fe..	8.43	13.73	[a]6.48

[a] Calculated.

The metallurgy of washing iron ore is peculiar in that little attention is paid to the tailing analysis, or to the iron unit recovery. Iron ore is sold on the basis of a guaranteed grade of iron, silica, alumina, manganese, and moisture. No attempt is made to obtain a product higher than the guaranteed grade, which is usually about 51.50 per cent iron natural. That grade must be obtained, or the product is not salable. Consistent with producing the guaranteed grade of product, the operator wants to obtain the maximum weight recovery.

Still another consideration is the structure of the various grades shipped. There is a nominal limit of 10 per cent by weight finer than 100 mesh, permitted in cargoes, and to preserve this figure in the different grades, or mixtures, the operator usually limits the minus 100 mesh in the washing plant concentrate to about 5 per cent. This helps to absorb the sometimes finer direct-shipping ores. It also results in the deliberate wasting of fine particles of high-grade iron oxide. The grade of tailing from the various washing plants will vary with the natural structure of the ore, from as low as 12 per cent to as high as 37 per cent iron. It has been shown by the excellent work of Professor Searles that much of this fine iron is recoverable.

The appealing thing about attempting to recover this additional tonnage is that the stripping, mining, and transportation costs are all paid for, the iron oxide particles are free from gangue, requiring no further grinding, and are in motion through the plant. No costs would be chargeable against the tonnage of fine iron ore recovered, except for the actual steps required for such recovery, and even these would be minimized. Little additional labor and no additional supervision would be chargeable, overhead resulting from fixed charges would be limited to interest and depreciation on the actual equipment cost; royalty would be charged only when based on tonnage shipped; and occupational tax should be charged. On the other hand, agglomeration at some stage prior to the blast furnace is a requisite and must be considered.

Usually, the washing plant flowsheet consists of screens and log washers or Dorr washers, supplemented by hand picking and secondary crushing and sometimes by jigging, and almost universally ending with bowl classifiers. The overflow of these classifiers constitutes the final plant tailing, except for varying smaller amounts of coarser rock, hand-picked, screened, or jigged out as waste or lean ore.

The classifier tailing is uniformly minus about 100 mesh in size, and the dilution varies from 17 to 27 per cent solids. As a general rule, in washing ore, about one ton of water is used per ton of original wash ore fed to the plant, and substantially all of this water reports in the bowl classifier overflow. This overflow contains the painty material, like clay, which, though it may contain considerable iron, is so finely divided that under present technique it is not recoverable. The overflow also contains fine particles of iron-stained sand and high-grade iron oxide. To get an idea of the recoverable value of this fine iron, now lost in the washing plant tailing, let us consider a plant of nominally one full-unit capacity, or 400 long tons of feed per hour. Let us assume, in line with average current practice, a weight recovery in the present washing plant of 65 per cent; further that the fine concentrate as shipped will contain 15 per cent water (this will be discussed in more detail later); and that the base price of 51.50 per cent iron natural ore is $4.50 per ton at Lower Lake ports, or $0.08738 per unit of iron. This is a fair long-time average, though considerably lower than 1938 prices. Also let us assume that a royalty of $0.65 per ton shipped is in effect, and that the occupational tax is 8 per cent of the gross mine value. The ad valorem tax on ore reserves would have little effect on this small additional recovery.

Then Table II gives the net value of the recoverable concentrate, f.o.b. cars at the mine. From this must be deducted operating costs and fixed charges, and these will be developed later.

These rather startling figures give us the amount of money which this fine concentrate is worth. The next question is, how much will it cost to recover this material and prepare it for feeding to a blast furnace.

It has been shown in the laboratory and also in plant-scale work that for any method of recovering this fine iron oxide, it is imperative first to get rid of the slime. If flotation is to be used, the presence of the slime results in a greatly increased consumption of reagents. If the tailing is to be tabled,

as has been done on considerable test work, and which will be referred to later, again the slime must first be removed to get better table operation. Presence of the slime tends to support and carry into table tailing the fine iron particles.

The first operation is therefore desliming. Use of the somewhat new tool of ore dressing, known as the Hydroseparator, is assumed in these calculations. This is employed in phosphate operations in Florida and Tennessee; also in removing slimes and unwanted fine sand when preparing close-specification sand for massive concrete structures, such as Grand Coulee dam; also for fine particle-size separations, as in the production of various paint pigments. It can be designed for any desired mesh or micron-size separation. Those in commercial operation are making separations as coarse as 28 mesh and as fine as 10 microns. Some handle as much as 700 tons of solids per hour. Hydraulic water is frequently introduced at the discharge cone, giving an upward hydraulic classification. This step eliminates the slime and much of the water, giving a deslimed underflow at the proper percentage of solids for flotation, this being variable as desired.

The next step is to condition the pulp, by adding a definite amount of soda ash to give the desired pH and agitating for a definite time. Here the use of the Turbo-mixer agitator is assumed. There are customarily two or more agitators in series, to minimize any possibility of short-circuiting. The soda ash would probably be added dry by a small belt feeder. The amount required per ton is small.

After conditioning, the pulp would go to the flotation cells, where reagents would be added. Professor Searles refers to the use of oleic acid. Sodium oleate is also known to be satisfactory —in fact it forms automatically from the reaction between the soda ash and the oleic acid. Much work on flotation of non-metallics has been done in the last few years, and many other reagents, complicated organic products, are now available and in many applications they give startling results.

Flotation would be carried out in two stages, the first giving a rough concentrate and a clean tailing which would go to waste; the second stage recleaning the concentrate, and returning a middling to the first stage. Following flotation, the cleaned froth would have to be dewatered, and this could be accomplished either with filters or with a continuous centrifuge, whichever showed the best results.

Operating cost down to this point has been rather carefully estimated, and is given in Table III. To this cost must be added fixed charges. Royalty and taxes have been taken care of in Table II. The principal remaining item is interest and amortization of the additional equipment required. Based on depletion allowances for computing income tax, 13 per cent of the investment cost is usually taken.

The installed cost of the additional equipment required is estimated in Table IV. This is predicated on handling say 80 tons per hour of deslimed tailing and producing 25 tons per hour of flotation concentrate.

Thirteen per cent of $85,000 is $11,000 per season as the fixed charge for interest and amortization. At a daily production of 600 tons for 150 days per season, the fixed charge per ton becomes $0.122. This added to the $0.443 operating charge gives a total production cost, up to the point of a dewatered product loaded into cars, of $0.56 per ton. Deducting this average cost figure from the respective net value figures, shown in Table II, we have a margin of value left as follows: Sample A, $1.22; sample B, $1.05; and sample D, $1.37. No charge has yet been deducted for agglomeration, and this will be discussed in a moment. First it should again be pointed out that it is perfectly feasible to recover this fine iron oxide by tabling, instead of by flotation. Considerable work has been done by the method mentioned, both in the laboratory, at the Mines Experiment Station, and at various washing plants. Typical results on deslimed tailing from three different ores, not the same as those used by Professor Searles and considered in the foregoing analysis, are shown in Table V.

The higher silicas in the concentrates in Table V, compared with the silicas in Table I, have no meaning, because these are entirely different wash ores, and a comparison means nothing. This information is included to point out that the possibilities of tabling should not be overlooked. Tabling might well prove cheaper than flotation, because no reagents are required.

After the dewatered concentrate, from either flotation or tabling, has been obtained, either of two general alternatives must be followed. The fine concentrates must be agglomerated before they can be charged into the blast furnace. They can be sintered direct, at the head of the Lakes, either alone (as at Babbitt) or mixed with coarser ore, as is the practice at the Evergreen plant. A central sintering plant handling these concentrates from several washing plants would be the probable answer.

Costs of sintering at the head of the Lakes, as presented by Perry G. Harrison, amount to about $1.10 a ton, if carried out on a large enough scale. To this must be added a switching charge, from the individual washing plant to the central sintering plant. No such tariff has been established, but for estimating purposes we can take a figure of $0.25 per ton. This makes a total cost for agglomerating the dewatered concentrate of $1.35 per ton. This apparently wipes out the margin available for all samples. However, the freight saving due to reduction in moisture, figured in Table II, must not be overlooked. If the sintered fines be assumed to have a moisture of 0.5 per cent, instead of 15 per cent, and also if the assumption is made that the unsintered fines carry no water of crystallization, then the weight is reduced and the grade is increased, and the calculations given in Table II must be refigured as given in Table VI.

In connection with the time to re-

Table II—Net Value of Recoverable Concentrates, F.o.b. Mine

	A		B		D	
	Tons	Fe (Dry), %	Tons	Fe (Dry), %	Tons	Fe (Dry), %
Washing plant feed	400		400		400	
Washing plant tailing	140	23.84	140	19.29	140	21.76
Deslimed tailing	62	29.83	40	27.83	103	23.75
Flotation concentrate	25	61.02	13	58.81	30	63.44
Flotation tailing	37	8.43	27	13.73	73	6.48
Flotation concentrate:						
Natural iron assay		52.02		50.00		53.92
Value per ton, Lower Lake		$4.55		$4.37		$4.71
Lake-rail freight		1.91		1.91		1.91
Gross value at mine		2.64		2.46		2.80
Less royalty at $0.65 and occupational tax at 8%		0.86		0.85		0.87
Net value per ton in cars		1.78		1.61		1.93
Moist tons per hour		29		15		35
Net value per hour		$51.50		$24.10		$67.50
Net value per 24-hr. day		$1,240.00		$580.00		$1,620.00
Net value per 150-day season		$186,000.00		$87,000.00		$243,000.00

Table III—Operating Cost

	Per Ton of Deslimed Tailing	Per Ton of Flotation Concentrate (a)
Desliming	$0.01	$0.033
Conditioning	0.005	0.017
Flotation	0.10	0.333
Filtration	.....	0.06
		$0.443

(a) Based on 30% weight recovery.

Table IV—Cost of Additional Equipment

Hydroseparator and conditioners	$15,000
Flotation equipment	25,000
Dewatering equipment	30,000
Building	10,000
Pumps, pipe lines, miscellaneous	5,000
Total installed cost	$85,000

Table V—Results of Tabling on Typical Ores

	Table Feed	Table Conc.		Table Tails
	% Fe	% Fe	% SiO_2	% Fe
Deslimed tailing, X	47.3	60.9	9.74	18.4
Deslimed tailing, Y	42.0	64.0	6.20	29.3
Deslimed tailing, Z	40.80	59.80	11.34	25.95

Table VI—Net Value Refigured for 0.5 Per Cent Moisture

Sample	A	B	D
Floatation concentrate, tons (dry) per hour	25	13	30
Dry iron assay	61.02	58.81	63.44
Natural iron assay at 0.5% H_2O	60.71	58.52	63.12
Value, Lower Lakes at $0.08738/unit	$5.30	$5.11	$5.52
Lake-rail freight, etc., at $1.91	1.91	1.91	1.91
Gross value at mine	3.39	3.20	3.61
Less royalty at $0.65 and occupational tax at 6%	0.92	0.91	0.94
Net value per ton in cars	2.47	2.29	2.67
Less:			
Operating cost, Table III	$0.443	$0.443	$0.443
Fixed charges per Table IV (Corrected to tonnage production)	0.122	0.234	0.102
Sintering and freight	1.35	1.35	1.35
Total costs	$1.915	$2.027	$1.895
Sample	A	B	D
Margin of profit per ton concentrate	$0.55	$0.26	$0.77
Moist tons per hour	25	13	30
Profit per hour	$13.75	$3.40	$23.40
Profit per day, 24 hours	$330.00	$81.00	$560.00
Profit per season, 150 days	$49,500.00	$12,200.00	$84,000.00
Return on investment	58.3%	14.4%	99.2%
Time to repay $85,000 investment	2 seasons	7 seasons	1 season

pay the investment, it might also be necessary to consider a proportionate share in the investment in a central sintering plant. Therefore, from Table VI, it is seen that even treating tailing B and sintering at the head of the Lakes would make a small profit, though not nearly so attractive as tailings A and D. Probably flotation treatment of tailing B would not be sufficiently attractive to be justified. It would depend largely on the life of the mine. With a long life ahead, it is likely that it should be done, but with only a five- or six-year life, it would become rather dubious. Obviously each particular operation must be individually analyzed.

Instead of sintering at the head of the Lakes, probably a more logical procedure would be to mix this fine concentrate with the bowl classifier rake product, ship these separately to the furnaces, and there mix this fine ore with the flue dust, a good part of which is dry and contains excess carbon for fuel, and sinter the mixture at the furnace. Inasmuch as all the necessary carbon is already present in the flue dust and cheap blast-furnace gas is available for ignition, sintering costs at blast furnaces are much cheaper than at the head of the Lakes. Sintering costs at furnaces are usually taken at $0.50 per ton. There would be eliminated the switching charge of $0.25 per ton to a central sintering plant, but obviously the extra water with the dewatered fine concentrate would have to be shipped down the Lakes. The profit from this method of treatment is refigured in Table VII.

Before doing this, however, certain precautions in shipping the dewatered fine concentrate should be pointed out. If mixed direct with the wet bowl classifier rake product, the dewatered fines will simply soak up the excess moisture, like a sponge. Therefore the rake product must be shipped separately. Being of coarser structure, it will drain, on the way to the docks, to about 10 per cent moisture. In the ore dock pockets this drained rake product, and the separately shipped dewatered fines, would be carefully mixed by scheduled dumping of cars, in accordance with present practice. Further mixing would occur in loading and unloading the boats, and a satisfactorily uniform mixture would doubtless have been attained by the time the cargo was in the furnace ore yard. There further mixing with flue dust takes place, and without question a satisfactorily sinterable mixture would be discharged by the pug mills.

From Table VII it is seen that if the recovered fine concentrate is sintered with the flue dust at the blast furnaces, treatment of all of the various tailings would be more profitable, although tailing B is still not particularly attractive.

In considering the cost figures in Table VII, it must be kept in mind that the royalty schedule will vary at each property, and this royalty is a large item in the net return on the investment. Also it should be kept in mind that in the near future natural gas may be available on the Mesabi Range. This will materially change the sintering cost at the head of the Lakes, but is hardly likely to upset the balance which now shows it to be more profitable to ship the fine concentrate separately and sinter it at the blast furnace. Ample sintering equipment is usually available at the furnaces, the large stocks of old flue dust formerly treated on these machines now being pretty well exhausted. Had 1938 iron ore prices been used, instead of an approximate long-time average, the economic picture would have been still more attractive.

The conclusion is inescapable that steps should be taken as promptly as possible, in such cases as show an economic profit, to recover the fine iron going to waste with the current tailing. It is doubtful if re-treatment of the fine tailing in the old tailing ponds can be found profitable. It is certain that grinding low-grade ores, such as lean-ore dumps, unaltered taconite, and the like, and treatment by flotation, would not, under present cost conditions, be profitable.

Table VII—Profit When Shipping Fine Concentrate and Rake Product Separately

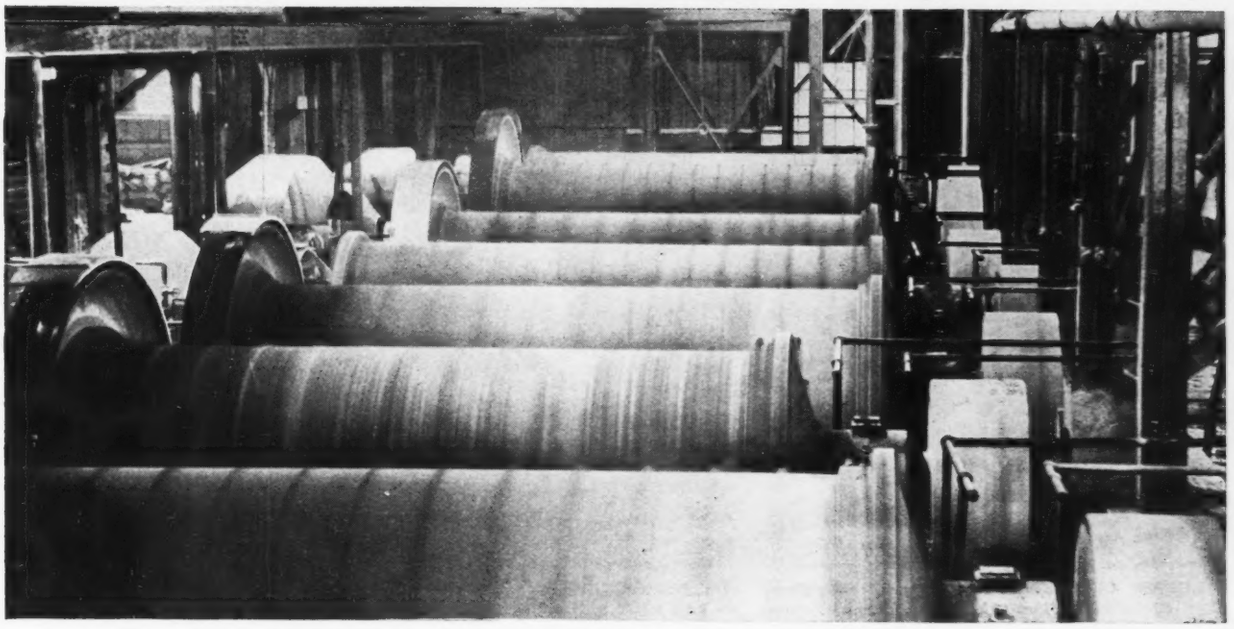
	A	B	D
Flotation concentrate, tons (dry)	25	13	30
Moist tons	29	15	35
Dry iron assay	61.02	58.81	63.44
Natural iron assay at 15% H_2O	52.02	50.00	53.92
Value per ton, Lower Lakes	$4.55	$4.37	$4.71
Lake-rail freight	1.91	1.91	1.91
Gross value at mine	2.64	2.46	2.80
Less royalty at $0.65 and occupational tax at 6%	0.86	0.85	0.87
Net value per ton in cars	1.78	1.61	1.93
Less:			
Operating cost, Table III	$0.443	$0.443	$0.443
Fixed charges per table IV (Corrected to moist tons produced)	0.105	0.203	0.088
Sintering (no extra freight)	0.50	0.50	0.50
Total costs	$1.048	$1.146	$1.031
Margin of profit per ton concentrate	$0.73	$0.46	$0.90
Profit per hour	$21.10	$6.90	$31.50
Profit per day, 24 hours	$510.00	$165.00	$755.00
Profit per season, 150 days	$76,500.00	$24,800.00	$113,500.00
Return on Investment	90.0%	29.2%	133.5%
Time to repay $85,000 investment	1+ season	3½ seasons	4½ months [2]

[2] Considering a season as 5¾ months.

▼ ▼ ▼

Diatomite Recovered by Flotation

SEVERAL samples of the marine diatoms of the Atlantic coastal-plain deposits have been treated successfully by flotation, according to United States Bureau of Mines Report of Investigations 3427. These deposits consist, roughly, of one-third each diatoms, clay, and sand. On pulping with water, the sand is easily disposed of except for a certain amount of fine quartz. The real problem is separation of the mixture of clay and diatoms that remains. The clay, with its huge adsorptive surface, will accept the flotation reagents before the diatoms can be filmed. It is easily frothed off if it has been properly dispersed. The most difficult problem was to disperse the clay out of the complex, tiny structures of the diatoms, as it is desirable to recover the latter intact. A pilot mill has been under construction and initial trials have been run at a favorable site on the Patuxent River. Snowy white diatoms have been left behind by dispersion and flotation of a brown limonitic clay, which normally causes the original mass to burn deep red. Recoveries in the laboratory have been over 90 per cent.



Tube mills, seven in number, are used to grind the rake product of the bowl classifiers, with which they are in closed circuit

Wright-Hargreaves Improves Its Milling Practice

II—*Grinding . . Classification . . Thickening, Agitation . . Flotation*

Malcolm Black
Mill Superintendent
Wright-Hargreaves Mines, Ltd.
Kirkland Lake, Ont.

PRIMARY grinding is done in one Allis-Chalmers 9x7 ft. ball mill and two 8 ft. x 30 in. Hardinge ball mills. The 9x7-ft. mill is driven at 18.5 r.p.m. by a 300-hp. synchronous motor, directly connected to the pinion shaft. Ball load, about 60,000 lb., is made up with 3½-in. cast balls. The liners are of manganese steel. The shell liners are of the lap-type, with a rounded nose. (We found the square-nose type had too much lifting action on the balls.) A "dishpan"-type screen, 4 ft. in diameter with 1x6-in. openings, is placed in the discharge end. This mill is in closed circuit with a 12x30-ft. Dorr FX classifier. A partition was placed in the center of this machine and each side was provided with a separate motor, so that either side, or both sides, may be operated.

The discharge from the ball mill is elevated to the classifier by means of a totally inclosed two-way scoop feeder driven by a 15-hp. motor through a reduction gear. The lips of this feeder are of manganese steel. When the points wear down, the casting is removed and taken to the machine shop and rebuilt by welding pieces of scrap manganese steel to the worn part. The two Hardinge mills are each in closed circuit with a 6x28-ft. Dorr duplex classifier. Both mills are driven at 21 r.p.m. by 150-hp. wound-rotor motors connected to the pinion shaft by short V-belt drives.

A complete set of liners for the 9x7-ft. Allis-Chalmers mill weighs approximately 43,099 lb. distributed as shown in Table I.

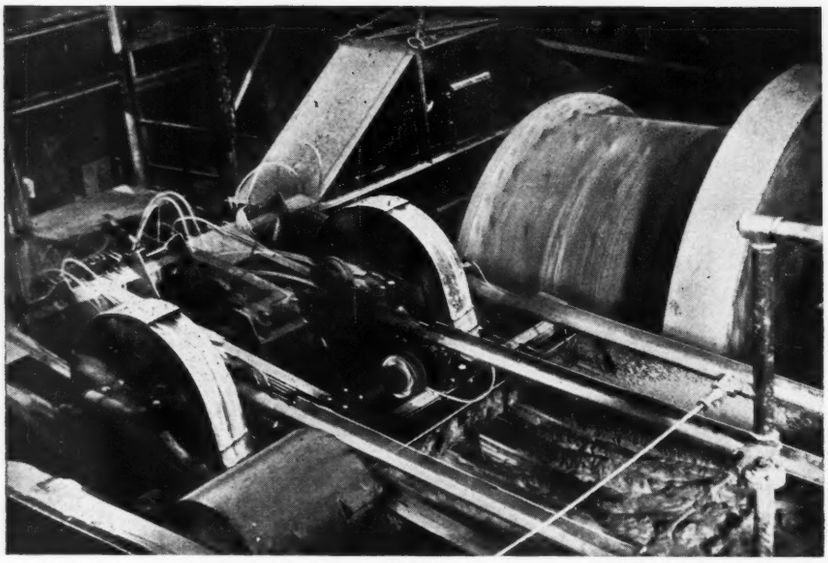
The two Hardinge mills are identical in respect to liner wear. A set of manganese steel liners weighs about 19,832 lb. Liners No. 1 and No. 2 are in the feed cone; No. 3 is in the cylinder, and Nos. 4, 5, and 6 are in the discharge cone. All liners excepting Nos. 1 and 6 are held in place with wedge bars, the total weight being about 19,382 lb. The wear is approximately as given in Table II.

Ball consumption in the primary circuit is about 2.5 lb. per ton. At 1,200 tons per day, the Allis-Chalmers mill grinds 650 tons and the Hardinge mills 275 tons each.

The surface units are calculated by the method suggested by Gross and Zimmerly as published in United States Bureau of Mines Report of Investigations No. 2882. They are given in Table IV. According to this, the large mill creates 1.92—1.62=0.3 surface units per horsepower-day more than does the smaller mill. This, of course, does not prove that the cylindrical type of mill is more efficient than that of the conical type. It does indicate, however, that a large mill is more efficient than are two smaller mills the combined volume of which is about equal to that of the large mill. This may be due to the difference in frictional loss.

Circulating Loads—Considerable experimentation has been carried on with a view to establishing the most suitable circulating load ratio to carry in the 9x7-ft. A.-C. mill with an initial 650 tons of new feed. Our 12-ft. FX classifier is of ample size to allow a circulating load of around 1,000 per cent, or a total circulating tonnage of 7,150 tons. The mill trunnions were also designed with a view to passing such large tonnages. The feed trunnion has an area of 380 sq.in.

Part I was published in the March number.



PRIMARY GRINDING is done in one Allis-Chalmers 9x7-ft. ball mill, here seen in closed circuit with a 12x30-ft. Dorr FX classifier, and in two 8 ft. by 30 in. Hardinge mills

(this has been reduced to 200 sq.in. by insertion of a special liner). Total area of discharge grate openings is 454 sq.in.

Table I—Liners for 9x7-ft. Allis-Chalmers Ball Mill

	Weight, Lb.	Life, Days	Wear, Lb./Ton
Feed end throat liners	1,902	200	0.0146
Feed end liners	6,582	200	0.0506
Discharge end liners	6,462	250	0.040
Discharge grate	1,270	100	0.020
Shell liners	26,883	365	0.113
Total			0.2382

Any attempt to circulate more than about 500 per cent has not been successful, owing apparently to one or more of several factors. In the first place, the ore consists mostly of hard syenite porphyry, and when ground it contains little or no slime. Without the buoyant effect of slime, the sands settle quickly in the classifier, making separation more difficult than with an ore containing a certain amount of softer material. In short, the amount of solution required to hold the proper density in the mill (with extremely large circulating loads) is more than required in the classifier. When this point is reached, obviously control of the unit is lost. It has been noted than the power consumption begins to fall off perceptibly when the circulating ratio reaches around 500 per cent. This is probably due to the crowding of small steel against the discharge grate, thus hindering free egress of the pulp, and consequently raising the center of gravity in the mill. With circulating loads between 200 and about 400 per cent, there seems to be free movement of the pulp through the mill. The circulating ratio is therefore held between those points. Under the circumstances, we have no way of proving or disproving the value of extremely high circulating ratios. Within the narrow limits as outlined, however, we find that the amount of new surface formed per horsepower-day is nearly constant regardless of the circulating ratio. The difference is that in the case of the large circulating tonnage, the classifier overflow will generally contain a greater amount of tramp oversize and less finished product in the rake sands, such as would obtain in the case of high rake speed.

In single-stage grinding, where a comparatively coarse separation and minimum amount of fines are desired, large loads (initial or circulating) seem to be the answer.

In reducing say — 65 + 100 mesh material to all through 200 mesh it is customary to use tube mills loaded with the size of grinding media best suited for that work. The assumption is that the reduction of that material is accomplished more economically by attrition between a great number of small balls than by impact of the larger balls used in the primary mill. In two-stage grinding, it is therefore desirous that material ground to a size suitable for tube-mill feed should be removed from the primary circuit as soon as possible, and not be allowed to circulate in that unit, occupying space that should be filled with the particles of larger size. Crowding the unit, as with large circulating loads or a maximum volume of new feed, appears to

Table II—Liners for Hardinge Mills

	Weight, Lb.	Life, Days	Wear, Lb./Ton
1 Set (12) No. 1 liners	2,546	140	0.066
1 Set (20) No. 2 liners	2,521	160	0.077
1 Set (20) No. 2 wedge bars	873		
1 Set (17) No. 3 liners	4,292	365	0.054
1 Set (17) No. 3 wedge bars	1,083		
1 Set (20) No. 4 liners	3,154	260	0.058
1 Set (20) No. 4 wedge bars	985		
1 Set (16) No. 5 liners	1,915		
1 Set (16) No. 5 wedge bars	720	260	0.037
1 Set (12) No. 6 liners	1,294	300	0.016
Total			0.308

Conditions	A.-C. Mill	Hardinge Mill
Tonnage rate	648	281
Actual horsepower to pinion shaft	309	162
Ball mill moisture %	29.5	28
R. p. m. of mill	18.5	22
Type of classifier	Dorr 12 ft. F X(x)	Dorr F 6 ft.
Circulating load	2.4:1	2.5:1
% Moisture in classifier	75	54
Ball load, lb	63,000	31,000
Size of balls fed	3½-in.	3½-in.

(x) only one side (2 rakes) in operation

Table III—Screen Analyses and Surface Units Obtained in Grinding Mills

		Screen Analysis							Surface Units per 100 Tons			
		9x7 ft. A.C. Mill			8x30 ft. Hardinge Mill				A.C. Mill		Hardinge Mill	
		Ball Mill	Classifier		Ball Mill	Classifier			Mill	Class	Mill	Class
Mesh	Cum. % Feed	Discharge	Sands	O'flow	Feed	Discharge	Sands	O'flow	Feed	O'flow	Feed	O'flow
+ 3	3.2	....	....	....	1.9	....	....	....	0.17	....	0.05	....
6	44.6	2.3	3.5	....	39.3	1.6	3.6	....	1.58	....	1.39	....
8	57.6	4.4	6.8	....	....	....	....	....	....	....	....	....
10	66.3	7.5	10.9	....	63.6	6.8	11.4	....	1.08	0.02	1.21	....
14	73.3	11.8	17.1	1.2	....	....	....	....	....	....	....	....
20	78.5	18.7	25.8	2.5	77.4	20.5	30.4	.6	0.83	0.28	1.03	0.04
28	82.8	29.0	38.7	6.1	82.8	33.8	47.9	3.5	0.39	0.52	0.50	0.30
35	85.9	40.6	52.7	12.0	85.3	46.5	61.7	10.4	0.35	0.88	0.42	0.93
48	88.4	52.3	65.5	19.9	87.8	57.7	72.3	20.5	0.37	1.49	0.44	1.77
65	90.5	64.1	77.9	30.7	89.9	67.1	80.2	32.8	0.405	2.59	0.47	2.76
100	92.3	73.5	86.7	42.3	91.7	74.3	85.4	44.5	0.48	3.42	0.54	3.51
150	93.5	79.2	91.1	51.5	92.9	78.9	88.4	53.1	0.44	3.40	0.48	3.44
200	94.7	83.7	93.8	60.8	94.1	83.1	90.8	61.9	0.52	4.36	0.62	4.58
−200	5.3	16.3	6.2	39.2	5.9	16.9	9.2	38.1	12.72	94.10	15.34	99.20
Totals									19.38	111.07	22.49	116.53

help in this respect. The greater velocity through the mill, the more granular the product will be. The velocity is, of course, dependent on the area of mill discharge.

The volume that may be handled in an overflow type of mill is greatly exceeded by that handled by the low-discharge type, especially those of recent design, and in use at one of the large gold mills in northern Ontario. The effect of rapid circulation through the mill appears to be not the creation of more surface units per unit of power consumed but the prevention of overgrind, and thus the production of a greater amount of a given mesh size per unit of power.

The overflow from the primary classifiers, plus the tube mill discharge, flows in rubber-lined launders to a pump sump. From here it is pumped by an 8-in. Hydroseal pump to a revolving distributor on the floor above, and thence to six bowl classifiers.

Feed to the Hydroseal pump consists of 1,200 dry tons original, plus a 200 per cent circulating load, or, a total of 3,600 dry tons at a liquid-to-solid ratio of 1:1. The pulp is nearly all minus-10 mesh and about 10 per cent plus-35 mesh. A 75-hp. motor is connected by short V-belt drive. This motor is somewhat larger than required, the actual consumption being about 60 hp. The total head is 55 ft., and the impeller speed 850 r.p.m. Data on wearing parts are given in Table V.

The distributor (see the photograph) consists of a cylindrical tank, about 3x3 ft. in dimensions, with an inverted-cone bottom. Near the bottom are four tangential outlets, spaced equally and made from 6-in. ells. In the inside there is a centrally placed rubber-covered Archimedes spiral about 16 in. in diameter. The entire unit is suspended on a vertical steel shaft which extends to and is welded to the bottom. The bearing is an old Wilfley pump unit supported on a steel superstructure. The pulp entering the tank impinges on the spiral. This and the back pressure from the outlets keep the unit revolving. Surrounding the unit is a circular launder to receive and distribute the pulp through adjustable gates to each of the six bowl classifiers.

Table IV—Surface Units as Calculated From Screen Analyses in Table III

	A.-C. Mill	Hardinge Mill
Surface units in feed	19.38x6.48=125.5	22.49x2.81= 63.2
Surface units in classifier overflow	111.07x6.48=719	116.53x2.81=326
Total units formed	719−125.5 =593.5	326−63.2 =262.8
Units per horsepower day	593÷309 hp=1.92	262.8÷162 hp=1.62

Table V—Hydroseal Pump Operating Data

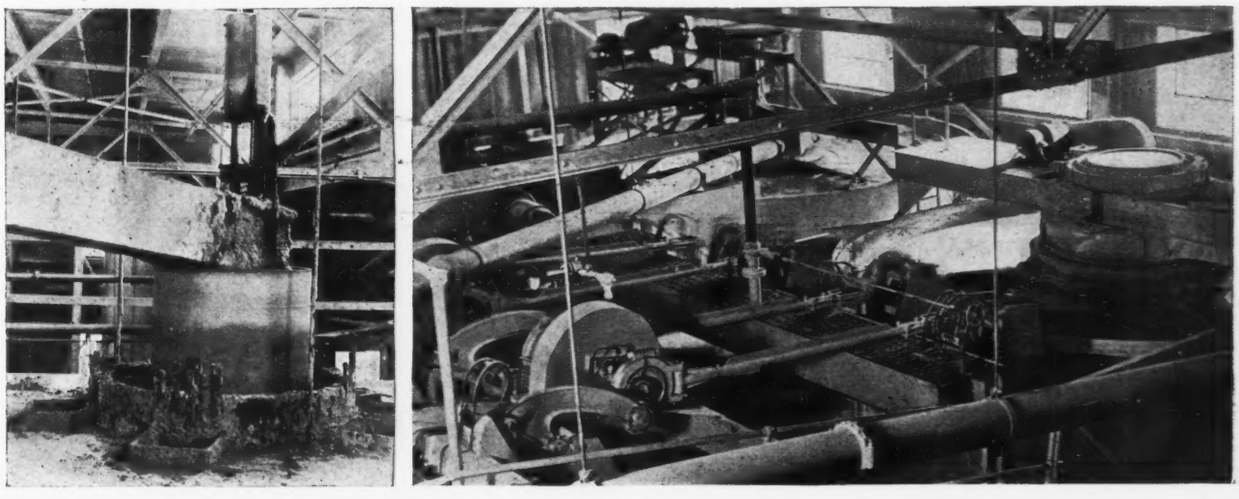
	Life/Days	Cost of Part	Cost/Dry Ton Milled	Cost/Dry Ton Pumped (3,600 Tons)
Runner	50	$135.00	0.2250c	0.0750c
Seal ring	38	4.00	0.0087	0.0029
Casing liner	270	123.85	0.0382	0.0127
Suction sleeve	730	27.50	0.0032	0.0011
Bell liner, engine side	365	23.50	0.0054	0.0018
Bell liner, suction side	365	22.50	0.0052	0.0017
Totals			0.2857c	0.0952c

Bowl Classifiers—This circuit, like most of the mill, has been added to at various times. Consequently, the machines are not all of the same model. All have 18 ft. bowls, but the original three are equipped with 6-ft. rake compartments and the newer machines have 16-ft. rake compartments. The former are model D.S.D.B. and the latter, Q.S.F.B. The wider rake compartments of the latter add considerably to the capacity. For a given fineness, the new machines will overflow about 225 tons each, as against about 175 tons for each classifier of the older model. Those with the narrow rake compartment are more efficient in that they produce a cleaner sand. The reciprocating rakes of the old machines make 12.5 strokes per minute and the bowl rakes, 0.726 r.p.m. The new machines, due to the wider compartments, are operated at 9.5 strokes per minute and 0.77 r.p.m.

Bowl classifier sands are returned by gravity in iron pipes to the tube mills on the floor below. There are seven of these mills, all of 5-ft. diameter. One is 14 ft. long and the others are 16 ft. long. Tube-mill liners are of chilled cast iron and are cast with closely spaced circumferential grooves of a width and depth to suit the size of ball being used. The liners are 2½ in. thick from the bottom of the grooves. Average life is about 654 days. Scrap from the average set of liners is equal to about 13 per cent of the original weight. Liner consumption is about 0.25 lb. per ton milled. Power consumption is approximately 170 hp. per tube mill.

Bowl classifier overflow with a liquid-to-solids ratio of about 9:1 flows by gravity from each of the six classifiers, to two Genter thickeners, each having a filtering area of about 2,000 sq.ft. Each machine receives 600 tons of solids, plus 5,400 tons of solution. This, however, is more than the machines are capable of handling. About 40 tons of solids and 800 tons of solution overflows from each machine and are sent to a 36x10-ft. Dorr thickener. Underflow from the Genters and the thickener is pumped by diaphragm pumps to two 24x26-ft. Dorr agitators in series. The Genter effluent is sent part to precipitation and

PULP DISTRIBUTOR (left) feeding the six bowl classifiers. It takes the overflow from the primary classifiers and the tube-mill discharge. Bowl classifiers (at the right), two of which are seen here, handle the overflow from the primary classifiers combined with the discharge from the tube mills. In the foreground is the new QSFB 16x30x18-ft. machine

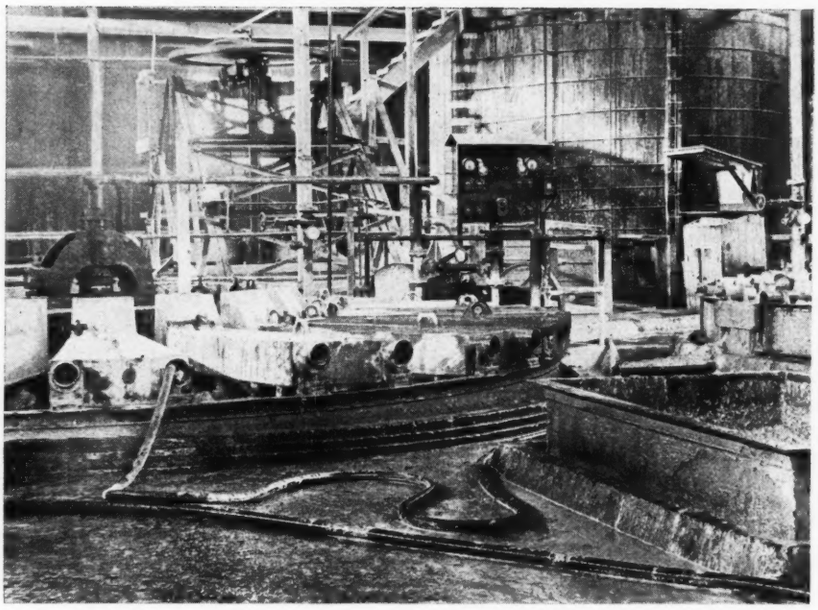


the remainder to grinding storage. The thickener overflow is also sent to storage.

The original tube frame or header assembly of the Genter thickeners consisted of 6-in. pipe to which the tube nozzles were attached. Each nozzle supported four to five tubes and each header had four nozzles, or a total of sixteen to eighteen tubes per header (sixteen headers to each machine). Almost immediately after the machines were put in operation, we began having trouble from the building up of hard cake between tubes. At first, this was thought to be due to the tubes being too closely spaced. Several tubes were therefore removed and the others re-spaced. This resulted in a slight improvement but did not entirely remove the trouble. After the machines had been in operation for about 30 days, we began replacing torn tube socks. It was then that the most serious "building up" started. From a study of the situation, it was obvious that one or more new socks on any header offered less resistance to the air "kick-back" than those that had been in operation for some time. Consequently the cake was discharging only from the tubes having new socks. Assuming this theory to be correct, we decided that if enough solution, in place of air, could be sent to all the tubes during the kick-back period, the problem would be solved. The action of solution is much slower than that of air; consequently, although more would escape through the new than through the old socks, the latter would receive enough to make a film between sock and cake and therefore allow the cake to fall off.

Several schemes to bring this about were suggested. These included placing a storage tank high above the machines and connected to the main Genter valves by a barometric leg. In this case, the solution would have to pass through a 2-in. tube and then through the main valve before reaching the header. The frictional loss in this case was much too great for sufficient solution to reach the tubes during such a short kick-back period (three seconds). If a solution kick-back were to be introduced, it was obvious that the solution must be stored on the header side of the valve. It was therefore decided to make up a few new headers with small tanks to replace the original 6-in. pipe. Several of this new type, equipped with a mixture of old and new tube socks were placed in each machine for trial. The old type headers continued building, but the new type were completely free from this condition. Both machines were hurriedly equipped with the new type, and no building has since been experienced.

Operation of the Genter Thickeners—Cost of operation with thickeners of this type is much greater than would be the case with those of the gravity type. Sock replacement is the principal item of cost. The average life of socks is about 30 days. Over a period of six months, the average number of replacements was 654 per month, or 327 for each machine. About 50 spare tubes with new socks are kept on hand continually. One man is employed almost exclusively on day shift replacing new socks on the spare tubes. One operator is employed on each shift, whose duties are to treat the headers with acid and to remove any tubes found with torn socks. Each header on both machines is treated with acid every other day approximately. In this acid-treating (see the photo) the header is first disconnected from the main valve and lifted by means of an air hoist mounted on a traveling crane. An air hose is connected and the entrapped solution blown out. The header is next lowered into a water tank, where the slime is washed off the tubes. It is next lowered into a rubber-lined tank containing a 3 to 5 per cent HCl solution, where it remains for a few minutes. It is then washed again and, if no torn socks are observed, it is put back in operation.



GENTER THICKENERS receive the overflow from the six bowl classifiers at a liquid-to-solids ratio of approximately 9 to 1. Each has a filtering area of about 2,000 sq.ft.

The Genter effluent, after reaching the receiver, is pumped direct to the clarifying presses. Should a few socks break in the course of operation and remain in that condition for any length of time, the clarifiers would become blocked with slime. It is therefore essential that there be some means for warning the operator when such breakage occurs. The system used is as follows: A ¼-in. pipe is tapped into each of the Genter effluent lines and led to the flasks placed in a conspicuous location. A small stream of solution is continually entering and leaving the flasks. When the solution becomes turbid, the operator knows immediately which machine has the torn sock, or socks. He must then find from which header the slime is coming. Each header tank is provided with a small valve which, when opened during the "kick-back" period, will discharge a quantity of solution. The operator therefore follows the "kick-back," taking a sample from each header until he finds the one responsible for the slime. Under normal operating conditions, air at 25-lb. pressure is used for the "kick-back." When the machines are being operated at a greatly reduced tonnage, as when lining a ball mill, the pressure must be reduced. Otherwise, many socks which have been in use for some time will tear, due to the increased pressure differential.

Primary agitation—The Genter underflow, at about 55 per cent solids, is pumped by two Denver Quad diaphragm pumps a vertical distance of about 3 ft. to the first of two 24x26-ft. Dorr agitators. Barren solution is added to make a 1:1 pulp. On this basis the pulp is agitated at this point for about 9.5 hours. The rakes on these machines are operated at 5 r.p.m., which is about all the mechanism will stand. This speed is not sufficient to keep the tank edges scoured. Pulp at this density and fineness will quickly build on the sides of the tank unless prevented. From an annular pipe on the top of each machine, air at 25 lb. is fed through several drop pipes, which reach nearly to the rakes. The ends of these pipes are turned slightly away from the edge of the tanks. Otherwise there would be danger of wearing holes in the steel. In addition, air pipes extend from the central air lift, along the top, and to the end of each rake, where they

are turned slightly upwards. Total air used in both agitators is about 5,000 cu.ft. The lifting chains on the agitators are incased in light water hose to a point a few inches above pulp line. The diameter of the hose is such that the chain fits tightly inside. Before this scheme was adopted, the chains, due to abrasion between links, lasted but a short time. With the hose covers, the indications are that they will last indefinitely.

Filtration—The filter plant comprises eight 14x16-ft. Oliver drum filters, for use on cyanide pulp, and one 11 ft. 6 in. by 14 ft. unit for dewatering concentrate. Filtration of cyanide pulp is done in two stages, with a short agitation period between. Although four filters are available for each stage, as a rule only three in each stage are in operation at one time. Pulp at about 50 per cent solids flows by gravity from the agitators to the first stage of filtration. Each filter is equipped with six spray pipes through which barren solution flows in sufficient quantity to prevent the cake from cracking. Each also has an individual repulper into which the cake falls, to be repulped with barren solution to about 50 per cent solids. First-stage repulpers discharge into a sump box from which the pulp is pumped to a 20x22-ft. Dorr turret-type agitator. Time of contact at this point is about three hours. The agitator discharge flows to the second stage of filtration. Four of the six spray pipes supply a barren solution wash and the two front pipes supply all of the make-up water. The repulpers in this stage are also fed with water.

Each filter is equipped with an individual drive consisting of a 3-hp. motor directly connected to a worm-gear speed reducer having a high- and low-speed sprocket. Corresponding sprockets on the filter drive shaft allow changing from operating speed to winding speed simply by changing the chain from one set of sprockets

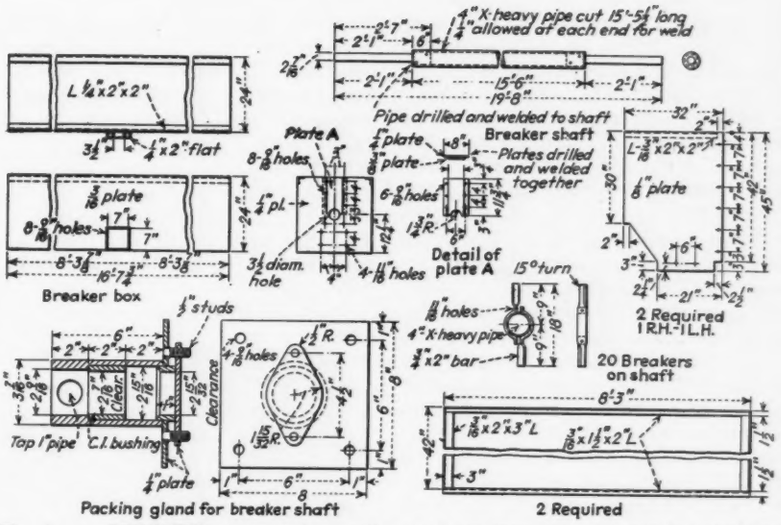


Fig. 4 . . . REPULPERS constructed according to these drawings are used for repulping the tailings from second-stage filtration before sending them to flotation

to the other. The present operating speed is one revolution in 3.25 minutes, and the winding speed 1.5 r.p.m. Six turns of wire at each end of the drum are wound immediately next to each other, the balance being at ⅞ centers, In all, there are about 230 turns of wire, the actual winding of which takes 2 hours 30 minutes.

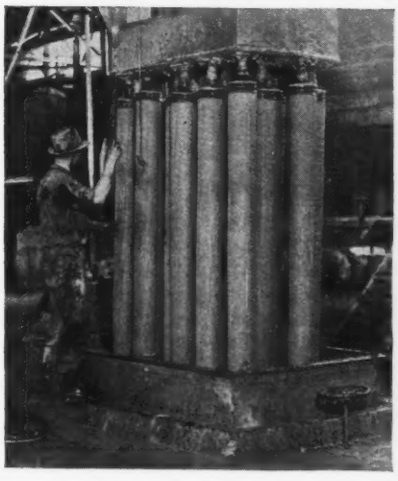
Due to the necessity of filtering directly after primary agitation, the pulp contains high-grade solution ($3.50 to $5.50), the maximum recovery of which depends on the condition of the filter medium. To maintain maximum efficiency, we find it necessary to scrub and treat the filters with acid frequently. This is because of the fineness of the pulp (about 40 per cent 10 microns). The first-stage filters are scrubbed and treated with acid every second day and those of the second stage every day. Lime carbonate precipitates to a greater extent on the second-stage filters, due probably to the CO_2 in the water used in this stage.

A mechanical brush is used (see photo) for scrubbing the filters. This consists of a steel frame, on which is mounted a 2-hp., 900-r.p.m. drip-proof motor, a crank shaft, a brush plate, two brush plate slides, and a waterproof starting switch. A 14-tooth sprocket on the motor shaft is connected by sprocket chain to a 94-tooth sprocket on the crank shaft. On each end of the crank shaft there is a crank disk about 10½ in. in diameter fitted with crank pins. Two connecting rods from the crank disks to the brush plate impart to the latter a reciprocating motion tangential to the filter drum. Two scrubbing brushes 4 in. wide and 50 in. long are fastened to the brush plate by means of clips. The brush plate makes about 135 strokes per minute. The length of stroke is about 9 in.

In preparing to scrub and acid-treat a filter, the feed is first cut off. The machine is kept in operation until the pulp level is down as far as the drum will take it and the remainder of the pulp is released to the sump. The vacuum valve is opened slightly, so that the acid solution may be absorbed into the cover. Then the brush is laid against the revolving drum at an angle of about 40 deg. and set in motion. A 3 per cent HCl solution, previously prepared, is fed immediately ahead of the brush by means of a perforated can fastened to the end of a pole (see photo). About 25 gal. of weak acid is required for each filter. There is enough carbonate in the cover, screen, and pipes to neutralize the acid. No attempt is made therefore to recover the spent solution. The actual time required to scrub a filter with one man is about 30 minutes, whereas it would take several hours by hand. Before the filter is again put in service, any holes found are patched in the usual way.

For using a scrubbing machine of this type effectively the operating floor should not be too far below the

TREATING the header of a Genter thickener with acid



SCRUBBING a drum filter with a mechanical brush and acid

top of the filter boots. In our case the floor is 12 in. above that point. The covers in use at present are made up from 20-oz. twill, and last for 60 to 90 days. Frequent acid treatment and scrubbing undoubtedly shorten the life of the cover. We find, however, that this is amply compensated for by the saving in dissolved gold.

Filter vacuum is maintained at about 26 in. of mercury by a B. & M. vertical, two-cylinder, two-stage, double-acting pump, driven by a 200-hp. synchronous motor. The machine has a displacement of 6,300 cu.ft. per minute. (This machine also supplies vacuum for the Genter thickeners.)

Low-pressure air for filters and Genter thickeners is supplied by an Ingersoll-Rand single-stage compressor, with a capacity of 1,400 cu.ft. When a greater demand is made on air, as on press days, a 350-cu.ft. machine of similar make is cut in.

There is a separate filtrate receiver and pump for each stage of filtration. A spare receiver and pump unit is hooked up so that it may be used on either stage. The filtrate pumps are of a single-stage, double-suction type with a capacity of 625 g.p.m. against a 105-ft. head, and are directly connected to 25-hp., 1,800-r.p.m. motors.

The repulpers (Fig. 4) are rectangular steel boxes 16 ft. 7¾ in. long, 2 ft. wide, and 2 ft. deep. The paddle shaft is made from 4-in. extra heavy pipe and extends the full length of the box. A piece of 2 7/16-in. shaft is welded to each end and extends through packed water-flushed glands to outboard bearings. The blades are made from ¾x2-in. strap iron, and are spaced at about 9-in. centers. The shaft is driven at 100 r.p.m. by a 1-hp. motor through worm-gear reduction, and sprocket chain.

Two 5x5-in. Allis-Chalmers S.R.L. pumps are in use, one for pumping first-stage pulp to the secondary agitator, and the other for pumping second-stage pulp to flotation. Both are connected by V-belt drive to 10-hp. motors, the total lift in each case being about 35 ft. Those pumps have been in operation for more than a year without interruption for repairs other than packing the glands.

Filter efficiency, as determined by assay of solution going to and leaving the filters, may be judged from the following figures:

	% Moisture	Value
Solution in feed to "A" filters	49.75	$5.37*
Solution leaving "A" filter repulpers	49.75	0.067
Solution in feed to "B" filters	49.5	0.2325
Solution leaving "B" filter repulpers	47.25	0.007
Solution in flotation tails	71.25	0.006

* Higher than usual.

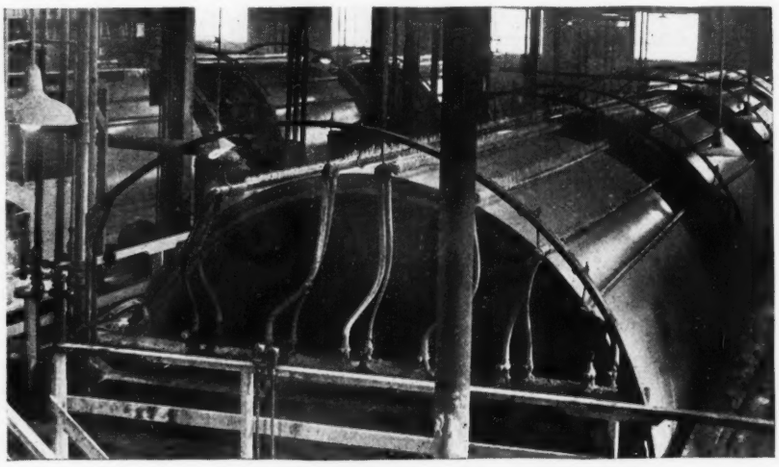
It will be noted that the solution going to "B" filters is higher in value than that leaving the "A" filters. This is accounted for by the fact that the pulp is agitated for a period between stages of filtration. A portion of the value in solution leaving the "B" filters is precipitated in the repulpers by the addition of $CuSO_4$ as a flotation reagent at that point. The amount precipitated is about 30 per cent. Therefore, the actual value in solution before addition of $CuSO_4$ is 1¢. The recovery of value in solution is thus 95.6 per cent in the case of second stage filters and 98.7 per cent for the first stage.

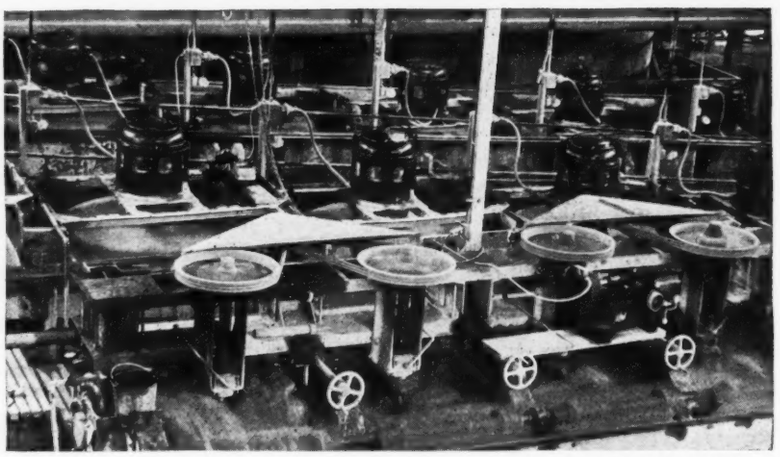
Flotation—Soda ash, $CuSO_4$, and Z8 (a butyl xanthate) are added to the second-stage filter repulpers, at the rate of 0.15 lb. per ton of solids, 0.3 lb. and 0.04 lb. respectively, each being dissolved before being added. The pulp is then pumped to a distributing box, where water is added to make a liquid-to-solid ratio of about 2½:1. It next flows by gravity to a 40-ft. Southwestern Hunt-type flotation machine, the tailings of which are split into two portions, each going to a separate bank of seven 56-in. Fagergren cells. Tailings from the latter are sent to waste.

Frothing oil is made up of nine parts cresylic acid, 25 parts B23, reagent and one part B25 (the latter two are Du Pont alcohols). Oil is added at the head of the Southwestern machine and at various other places in the circuit.

All concentrate produced by the Southwestern and Fagergren cells is sent to a 36x10-ft. Dorr thickener. Attempts to re-use the overflow from this thickener have been attended by difficulty in controlling the froth. It also produces a high tailing and a low-grade concentrate, due apparently to the presence of some inhibiting agent. It is therefore sent to waste. The thickened rougher concentrate, representing a ratio of about 30 into 1, is sent to a bank of eight Denver Sub-A cells for cleaning. Tails from this machine are returned to the head of flotation and the cleaned concentrate, now having a ratio of about 100:1, and sometimes much higher, is sent to an 11½x14-ft. Oliver filter. A water spray is used in an effort to remove reagents from the concentrate.

The filtered concentrate is repulped with enough water to make it flow in a steep launder to a 5x20 Hardinge mill, the grinding media in which consists of pieces of ore about 3- to 4-in. ring size. Crushed dry lime is added





FILTRATION (upper picture) of cyanide pulp is done in two stages, eight 14x16-ft. Oliver units being used. Another unit serves for dewatering concentrate. On the flotation floor (lower picture). Here the second-stage filter tails are floated in a 40-ft. Southwestern Hunt-type machine, followed by Fagergren cells, which make a final tailing

to the mill at the rate of about 25 lb. per ton of concentrate by means of a slowly moving conveyor belt. The mill discharges into a screened pump box where a constant stream of strong cyanide is added, to make a liquid-to-solid ratio of 2:1. The pulp is then pumped to the re-treatment circuit which consists of seven 12x12-ft. Denver Wallace agitators in series. Before entering the Hardinge mills the concentrate is already in an extremely fine state. The function of the mill is therefore not so much that of regrinding but to afford the metallurgical advantage gained by the intimate contact between the gold-bearing tellurides and fresh lime followed by the addition of strong cyanide. The reaction on at least a portion of the gold-bearing constituents, with this method of treatment, appears to be extremely rapid. This is especially noticeable when the concentration ratio reaches the proportion of around 300:1, which happens occasionally.

A comparison of analyses of samples taken before and after the addition of high lime and cyanide is given in Table VI.

These samples were taken during a routine sampling period. It happened, however, that the ratio of concentration during this particular period was somewhat higher than usual. Both samples were taken over a period of 24 hours and permanganate ($KMnO_4$) was added to the second sample to arrest the action of the cyanide. The time between sampling points—that is, the time lapsed from the moment the pulp leaves the filter until, after passing through the mill, it is pumped to the retreatment circuit—is but a few minutes. In this short period, according to the analysis given, 70 per cent of the gold, 36 per cent of the tellurium, and 35 per cent of the sulphur have been taken into solution.

This condition does not, however, obtain throughout the subsequent period of agitation. The 97 per cent extraction obtained in this circuit requires the full agitation period of two to three weeks. Our belief is that the portion which goes into solution so quickly is that in which the gold is in the form of extremely fine tellurides, partly decomposed in the main circuit and in such condition that the high-lime and cyanide rapidly completes the decomposition.

We do not think that free gold in such a fine state of subdivision could reach flotation without being dissolved. Microscopic examination of "superpanned" concentrate shows very little free gold, but a good deal of gold-bearing tellurides and some sulphides, including pyrite.

As already stated, the concentrate, after treatment, is returned to the main cyanide circuit. In other words, it is in a closed circuit. On first thought, the affect of this would seem to be to build up an increasing amount of sulphides in the circuit. This, however, is not the case. Of the 0.7 per cent sulphur in the flotation heads, only about 8 per cent is floated and it is either broken down in the cyanide circuit or becomes so tarnished that it fails to float again.

Distribution of Values in the Tailings—The method used at this plant to determine the distribution of the values in the tailings is as follows: A large sample of tailings, preferably a composite of daily samples taken over a period of time, is thoroughly mixed and carefully sampled. The assay result is taken as representative of the heads for the test. The large sample is next cut into two equal portions and designated "A" and "B."

Sample "A" is re-cyanided for 36 hours to determine the amount thus recoverable. Sample "B" is treated with a 10 per cent solution of hydrochloric acid to release the value locked up in carbonate. It is next washed thoroughly, repulped with barren solution, and agitated for 36 hours. After washing, it is again sampled. The assay value of this sample, subtracted from the original head sample, represents the value recoverable by cyanide plus the amount that is locked up in the carbonate. The sample is finally treated with aqua regia to determine the amount locked up in the insoluble portion. Data of an actual test for failure to extract is given in Table VII.

The reliability of a test in which aqua regia is used as the solvent has been questioned. It is possible that there is a certain amount of disintegration of the gangue particles, particularly those of the large sizes, which may contain partly exposed mineral that the cyanide failed to dissolve, but was later acted on by the greater solvent action of the aqua regia. If this is so, the sulphides are erroneously credited with a part of the value which really belongs to the insoluble portion.

At another mine in the district, where extensive research has been conducted with the use of the Haultain Infra sizer and Super panner, the aqua regia test has definitely been found unreliable for the reasons mentioned in the foregoing. No attempt has been made so far to float the pyrite at our plant other than in laboratory tests.

About 80 per cent of the pyrite may be floated by the addition of enough acid to bring the pH down to around 7 to 8. This requires in our case about 10 lb. of acid per ton of ore. About 30 per cent of the value in the pyrite may be extracted by fine grinding and agitation in cyanide solution. The cost in this case is much greater than the saving. By roasting the pyrite concentrate and returning the calcine to the circuit, an extraction of 90 per cent may be made. At a neighboring mine where the sulphur content of the ore is slightly higher than that of our ore, the operators are preparing to roast. The SO_2 gas produced in roasting will be used for acidifying the flotation feed, thus eliminating the cost of acid.

Research at our plant respecting these technical procedures indicates a saving over cost. The calculations are as follows:

FeS_2 content of flotation heads (assuming sulphur to be all in form of FeS_2)—1.4%

Amount of pyrite available when 1,200 tons of ore is milled daily is 1,200x1.4%, or 16.8 tons FeS_2

Value of pyrite per ton, $18

Assuming 80% of pyrite recovered and 90% extraction of contained value, this gives 72% of total extraction, or $12.96 per ton of pyrite. $12.96x16.8=$217.73 per day. $217.73 divided by 1,200=18c per ton of ore milled, or, based on gold at $35 per oz.,=31c. per ton.

The cost of roasting and other steps in the process, such as conditioning before flotation, filtering, and drying, have not yet been compiled. Cost of roasting would depend on whether a self-roasting concentrate can be maintained. In short, the scheme looks attractive enough on paper to warrant attention, but there are many points to be ironed out before we could make a definite decision to adopt it. Present research is being conducted as to these details.

(To be concluded)

Table VI—Analyses of Flotation Concentrates Treated in Hardinge Mill

Before Adding High Lime and Cyanide

	% Before	% After	% Dissolved
Au	0.058	0.017	70.7
Cu	0.400	0.19	52.5
Te	0.415	0.263	36.6
Fe	6.860	5.460	20.4
Pb	0.945	0.430	54.5
S	4.350	2.820	35.2
SiO_2	47.500	49.500	
Al_2O_3	18.480	19.400	
$CaCO_3$ ...	8.500	10.01	
$MgCO_3$ ...	11.950	13.99	

Table VII—Test for Failure to Extract

500 grams pulp, value 36c, FeS_2 1.13%
Added 1000 c.c. barren solution
Added 2.0 grame lime
Added 0.2 grams NaCN
Agitated for 36 hours, filtered and washed
Titrations, KCN 1.2 lb., PA 1.8 lb.
Value in gold, $0.33
HCl and cyanide test
550 grams pulp, 750 c.c 10% HCl (for 2 hours). Filtered and washed thoroughly.
Ad 1,100 c.c., barren cyanide solution, 2 grams lime and 0.2 grams NaCN. Agitated 36 hours.
Titrations, KCN 0.8 lb., protective alkalinity 0.8 lb. Filtered, washed and dried. Weight 511 grams.
Assay, $0.28; FeS_2 1.14%. Treated with aqua regia. Assay $0.08. Loss in weight (carbonates) 7.1%.

Assay corrected to original weight	$0.26
Assay FeS_2	1.07%
Conclusions	
Directly available tc cyanide..	$0.03
Locked up in carbonates.....	0.07
Available by aqua regia (sulphides) and probably some tellurides	0.18
Locked up in the insoluble....	0.08
Total	$0.36

Safety Pays at United Verde

Earnest efforts have made the open pit a very safe place in which to work

Gilbert E. Campbell
Phelps Dodge Corporation
Jerome, Ariz.

THE MANAGEMENT of the Phelps Dodge Corporation believes wholeheartedly in safety. From the time the property now constituting its United Verde Branch was acquired by the company early in 1935, it has striven for improvement in this phase of operations. Up to the time of the purchase safety work had been more or less of a "one-man job," the full responsibility for it falling upon the safety engineer of the organization, cooperation of the other bosses being somewhat casual. The new management decided that every one, from manager to mucker, should be made safety-conscious, and the safety work was recognized with this in mind. A General Safety Committee was created, which was composed of all branch managers, headed by the vice-president. Branch committees were set up, each composed of the department heads of the respective branch, with the branch manager as chairman. At United Verde this committee includes the mine and smelter officials, the mine having its own subcommittee in each department and likewise the smelter. A department head acts as chairman of the subcommittees in his department.

The subsequent discussion is confined to the Pit Department of the Mines Division of the United Verde Branch. The subcommittees functioning at present are: 1, pit bosses; 2, office force; 3, shovel and truck crew; 4, drilling crew and powder gang; 5, pit mechanical department.

These subcommittees are composed of both bosses and workmen. The former attend all meetings, whereas the latter members are rotated every three months. Thus all the workmen have a chance to serve, and the meetings are kept small enough to be effective and do not become boresome.

Committees and subcommittees meet monthly and discuss questions pertaining to operation and efficiency as well as safety. Minutes are kept, providing a record of the proceedings and serving as a check on safety improvements.

Suggestions as to making working conditions safer are invited, this system being found to give gratifying results. Suggestions may be made at any time by any employee and not necessarily at meetings only. Those offered are recorded on a card, which is given to the foreman concerned. Those calling for the purchase of new equipment or large expenditures of money are referred to the manager by the general pit foreman. To date no suggestion has been turned down for money reasons alone.

A code of safe practice has been written covering every operation in the pit department. Twenty-six such codes have been in force the past year. That they have been effective will be shown later. Their preparation was accomplished by interviewing the workers themselves. For example, the code for drilling and blasting was prepared by daily study of the methods employed, suggestions as to improvements being obtained from jackhammer men, surface miners, bank miners, and Leyner men. Picked men engaged in these various operations also submitted written papers on the procedure of their particular jobs. It was indeed surprising that such sound ideas were advanced by these men once they were given the opportunity to express themselves. On completion of a code it was checked by foreman and jigger boss of the operation, and after additions or eliminations was mimeographed and distributed. To insure that the codes would be studied and thoroughly understood, the men were taken in small groups during working hours, for approximately an hour at a time, and the codes were reviewed with a safety engineer acting as instructor. This proved satisfactory, and in many conferences further improvements in the procedure prescribed in the code were arrived at.

The codes have since been reviewed every six months, with resulting benefit. At the same time review of the company rule book is also made. New employees are supplied with a code relating to their particular work and after several days are questioned to determine if they have studied it. A safety talk is also given them by their foreman on the first day of work. Men transferred to other departments are treated as new men.

This intensive campaign has been under way now for more than two years. Results accomplished are indicated by the figures for 1936 and 1937, taken for comparison from the yearly accident report of the Safety Department. Converting these shifts to man-hours gives the figure of 427,056 without a lost-time accident. It is a record to be proud of.

Lost-Time Accidents

Year	No. of Accidents	No. of Shifts Worked	Frequency Rate Per 1,000 Shifts
1936	5	66,882	0.075
1937	0	53,382	0.000

No Lost-Time Accidents

1936	107	66,882	1,600
1937	86	53,382	1.611

At first glance the figures for the "no lost-time accidents" appear to show a slight decline rather than a gain. To illustrate this point and to show how we really have gained, it would be well to explain the fact that from the first the company has insisted that all accidents, regardless of severity, be reported and be attended to by a doctor. At the beginning it was hard to get this done, inasmuch as a man felt ashamed to report a scratched finger, a bruise, or a speck of dust in the eye. He felt that such conduct would reflect on him in some way. Today all such minor accidents are willingly reported and are included in the figures given. This may help to explain the unusually high accident frequency of "No Lost-Time Accidents" in 1937 to 1936.

As to the hazards confronting the open-pit worker, I will try to point out the most dangerous of them faced by the men in their daily work, and also give a brief résumé of the methods used to combat or eliminate them.

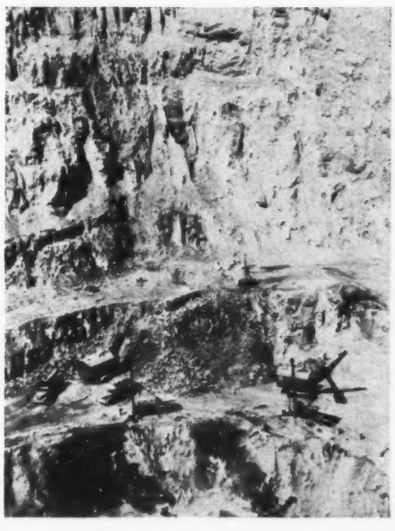
The mining methods employed at the United Verde pit are similar in most respects to those used in other open pits, with the exception that disposal of material is made by trucks

dumping into raises to underground haulageways and thence to the smelter. The working benches of the pit at present limit its maximum size to approximately 400 by 700 ft. Above the uppermost bench tower the pit walls, the minimum height of which is 130 ft. and the maximum 310 ft. (Photo shows a partial view of high pit walls and concentrated working areas). These walls, in the area of most danger, are composed of diorite that is badly shattered as a result of the old method of coyote blasting. Immediately after rains or during high winds they are continuously sloughing off, to the danger of men below. This menace is minimized by constant barring down of loose material, to which work 2,080 shifts have been directly charged to date. (A blast may be made on the high bank that is being trimmed solely in the interest of safety.) Periodic patrols of these areas are made by experienced bank miners. Where a new crack or movement is noticed, survey points are placed on the areas affected and a constant watch is kept for additional movement. To date only small caves have taken place and these have given sufficient warning so that men and equipment have been removed from the danger zone days ahead of time.

Operations in the pit, such as drilling and blasting, springing and loading, shoveling and hauling, present a safety problem that no one man could expect to cope with alone. Here it is that the codes previously mentioned are most effective in that they make a safety engineer of each and every man in the pit. At the beginning of the campaign it was noticed that production suffered slightly, but as new ideas as to safety multiplied, increased efficiency beyond the previous normal resulted.

All near-accidents, or those accidents resulting in material damage only, are investigated by the bosses and the safety department. A written record is kept of the findings and recommendations. It is perhaps unnecessary to say that proper steps are taken to see that a similar accident does not recur.

HIGH WALLS, here seen in part, tower above the uppermost bench in the United Verde pit



The more noticeable improvements in pit practice and efforts toward safety may be summarized as follows:

1. More stress applied to coordination between operations to eliminate congestion and minimize overlapping of men doing their various jobs.

2. Introduction of safety matches to all men handling powder. These are supplied to them by the company.

3. Elimination of dust by the use of water when loading with shovels.

4. Placing of heavy guard rails with timber curbs around all road curves that have an outside drop-off.

5. Upkeep at all times of fences around raises.

6. Removal or instant repair of all equipment that is found to be faulty or unsafe.

7. Required wearing of hard hats and hard-toe shoes as parts of apparel, with safety goggles used in dusty conditions or whenever the work requires eye protection.

8. Installation of safety devices or practices wherever attention to such an improvement is noticed.

9. Use of posters and other visual means of keeping safety before the men at all times.

10. Introduction of hot-wire spitters wherever fire fuse is used in blasting.

11. Maintenance of safety shelters at convenient places in the pit.

12. Maintenance of bank watchmen on duty with a warning whistle at all times during working hours.

13. Attendance required at first-aid classes yearly under the direction of the Bureau of Mines, for which the men are compensated.

It is the opinion of those who have seen the results of this safety campaign develop from a one-man attempt at safety to the creation of a very safe place in which to work, that any company or operation honestly desiring safety may have it by the simple expedient of making proper preparation and thorough application. A suggested outline for those interested, modeled on that in effect here, may prove of interest.

1. As previously said, the company or group interested must sincerely desire safety.

2. Write codes of safe practices to govern all operations in the mine or plant.

3. Select men that are primarily interested in safety, train them in the new order, and in turn let them instruct their fellow workmen.

Safety for Heads, Eyes, and Lungs

FOR SEVERAL YEARS a revision of Handbook H2 of the Bureau of Standards containing the "National Safety Code for the Protection of the Heads and Eyes of Industrial Workers" has been under way. In preparing a new edition, the scope of this code has been extended to include protection of the respiratory tract from the inhalation of gases, fumes, and dusts which might produce injury. The best-known example of such injury is silicosis.

The new edition has appeared in Handbook H24 under the title "American Standard Safety Code for the Protection of Heads, Eyes, and Respiratory Organs." The revision was carried out by a sectional committee of 40 members representing the various points of view held by regulatory authorities, employers, employees, manufacturers of safety equipment, insurance organizations, and experts on this subject. The code gives specifications for goggles, respirators, welding helmets, protective hats, and similar examples of safety equipment for protecting the eyes, heads, and lungs. Eleven different types of protection are given consideration and the necessary properties for the protective device in each case are set forth. Specific tests to determine the suitability of different types of protectors are included. A discussion of the rules is included which shows the necessity for providing protective equipment for exposed workers, explains the reasons for certain of the rules, and is intended to assist in the interpretation and application of the code.

Copies of Handbook H24 can be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15c. per copy. The code has the approval of the American Standards Association.

▼ ▼ ▼

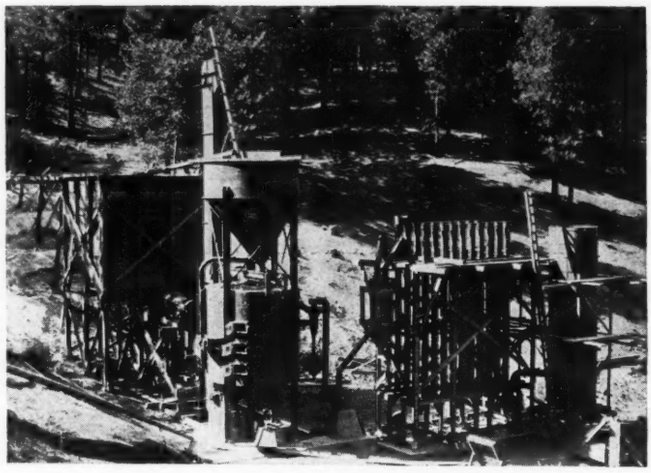
Lead in Steel

LEAD PIGMENTS and enamels are reported to be meeting much competition from other materials. For batteries, cable sheathing, plumbing, and proofing against chemical corrosion, however, the metal is still doing well. *Metals and Alloys* for November 1938, Vol. 9, page A-19, contains a note on the use of a few tenths of a per cent of lead in steel, whereby the machinability of the material is increased. Enough work seems to have been done to give promise for a new use of lead in considerable quantity.

Quicksilver Metallurgy Today

Advance marked in improvement of mechanical furnaces, dust collectors, condensing systems, and other equipment that was used during the War period

Alfred L. Ransome
Mining Engineer
San Francisco, Calif.



20-ton Herreshoff furnace and condensing system under construction at Great Western mine, Lake County, Calif. A 6-in Sirocco dust collector is shown between furnace and condenser pipes.

SINCE THE PERIOD of the World War no basic change has transpired in the metallurgy of quicksilver. During the intervening years serious thought was given towards the improvement of the methods existing then for beneficiating the quicksilver ores of lower grade that were being mined. Gravity concentration and flotation were tried without marked success, but the mechanical furnace, particularly the rotary type, previously unsuccessful, finally proved its practicality and rapidly replaced the old stationary brick type of reduction plant. The multiple-hearth type of mechanical furnace, although successfully adapted to use on quicksilver ore, did not come into more general use for some years. Condenser designs were improved, and the old brick chambers were changed to the combination of sewer-tile pipes and redwood tanks. During the past few years, the greatest advance has been made in improving the designs in use during the War period, including mechanical furnaces, dust collectors, condensing systems, and the types and grade of fuel used for firing the furnaces.

Preliminary treatment in the form of concentration can be classified as follows: (1) hand sorting; (2) screening, alone or in combination with scrubbing; (3) jigging; and (4) flotation. Hand sorting is the simplest operation, and is almost universally used during some phase of the ore handling for the purpose of raising the grade. Screening is resorted to when the balance of the mineral occurs in the fines. Mechanical scrubbing is not generally employed but is applicable to certain ores. From the standpoint of large-scale operation, shaking tables have not proved to be entirely satisfactory in numerous experimental trials when used as a primary means of concentration. The cost of fine crushing offsets the possible saving thus attempted. There are instances of tables being used today, particularly on smaller properties, as a preliminary treatment prior to small-scale retorting. Concentration by more crude, but similar, methods is obtained by the use of hand-made sluice boxes that may or may not be mechanically shaken. Jigging is primarily used for gravity concentration of relatively fine material. At the well-known New Idria mine, in San Benito County, Calif., 42-in. Bendelari jigs are now being used as the principal means of concentrating low-grade ore. The ore, averaging 5 lb. of quicksilver per ton, is raised in grade to from 12 to 15 lb. per ton, the resulting concentrate being treated in rotary type furnaces.

Many attempts have been made to float cinnabar. Bradley[1]—in 1616-17 made a number of laboratory tests on samples of quicksilver ore from various mines in California, with good results in instances. The same general objection holds true with flotation as in the use of the shaking table—namely, the cost of grinding to the necessary degree of fineness is prohibitive for large-scale operations. This does not mean that use of flotation is precluded. At the Sulphur Bank mine, in Lake County, Calif., two flotation cells are in operation for concentrating the partly dewatered product of the thickeners which contains finely divided particles of quicksilver. The flotation concentrate subsequently is filtered, dried, and retorted. In the future, more extensive use of flotation is probable. Since Bradley made the tests mentioned, using oil reagents, advance has been made, especially with the development of reagents specifically designed for use on different minerals. Flotation was tried on a large scale at the Sulphur Bank mine about 10 years ago with a view to treating old dump material. Xanthates were used. The plan proved unsuccessful, due primarily to the highly acid condition of the material treated and the presence of much elemental sulphur.

Two principal types of mechanical furnaces are in use for beneficiating quicksilver ores—namely, the rotary kiln, similar to that used in cement plant practice, and the multiple-hearth furnace of the McDougall, Wedge, or Herreshoff type, in which the ore is mechanically rabbled. Other types that are mainly experimental include mechanical retorts and continuous-muffle furnaces. The main advantages of these are the greater capacity as compared with the current type of hand-charged retort, and the simplification of the condenser problem resulting from the absence of the by-products of combustion from the gas stream. Many attempts have been made to operate such retorts and continuous-muffle furnaces, mainly with negative results.

Prior to 1916, attempts to use the rotary kiln for beneficiating quicksilver ore were mainly negative in result. As early as 1876, before the advent of the Scott furnace, Purnell[2] suggested the use of a rotary furnace of the cement-plant type for reducing quicksilver ores. In 1903, a White-Howell rotary roaster was installed at the Socrates mine, in Sonoma County, Calif.[3] The kiln measured 5x50 ft. (outside diameter), was inclined 6 in. in 50 ft., and had a lining of 6-in. firebrick. Wood was used for fuel. The speed of rotation of 22 r.p.h. allowed the passage of ore

through the furnace within 3¾ hr. Operation was discontinued after a short unsatisfactory trial, and the furnace was later installed as an ore drier above a 40-ton Scott furnace. In 1911, a rotary type kiln was installed at the Aurora mine, in San Benito County, Calif., which burned fuel oil.[4] Mechanical troubles developed and the operation of the plant was irregular. It has been reported that a rotary furnace was erected and placed in operation at the Abbadia San Salvatore mine, at Tuscany, Italy, in 1913.[5] According to H. W. Gould,[6] this particular rotary unit was installed not as a reduction furnace but as a drier (one of the three finally erected) for the treatment of the extremely wet ore mined in that district. Gould further stated that it was not until 1921 that a kiln type of furnace was installed for reducing ore, and from personal observation described the motion of the kiln to be oscillatory rather than rotary. This design was used in an attempt to alleviate the dust problem that had been a serious obstacle in previous furnace operations.

The first successful experimental rotary furnace was erected at the New Idria mine, in San Benito County, Calif., and placed in operation August, 1916. The installation was made by H. W. Gould, then general superintendent, and the almost instant success of this plant resulted in additional furnaces being built both at this and other mines. The shell of the furnace mentioned measured 4x50 ft. (outside diameter), was inclined 1 ft. in 28 ft., and rotated at 1½ r.p.m. The lining consisted of 4-in. radial firebrick. Preheated oil of 18 gravity was used for fuel, being atomized with steam. The furnace handled 80 tons of 1-in. ore per day, and consumed an average of 6.65 gal. of fuel oil per ton of ore treated. Ore was fed into the furnace by means of a rotating screw conveyor passing horizontally through the concrete dust chamber. Minor troubles were encountered, but on the strength of the success of this furnace, four similar furnaces measuring 5x56 ft. were installed in 1917. Currently (1938), only two of these are in operation.

Essentially, the rotary furnace consists of a revolving tube with a firing hood on the lower end and a dust header on the upper end. The ore is fed into the tube through an automatic feeder at the upper end, and as the tube revolves it works the ore down to the discharge end. Firing is done with fuel oil through a high-pressure burner extending into the tube, with the fire and heat playing directly on the moving ore. The burned ore, or "calcine," is finally discharged into a burned-ore bin or conveyed directly to the dump. The gases, including mercury vapor, dust, and products of combustion, are drawn from the upper end of the tube through a dust precipitator, whence they pass through a system of condensers and settling tanks before being released to the atmosphere through a stack.

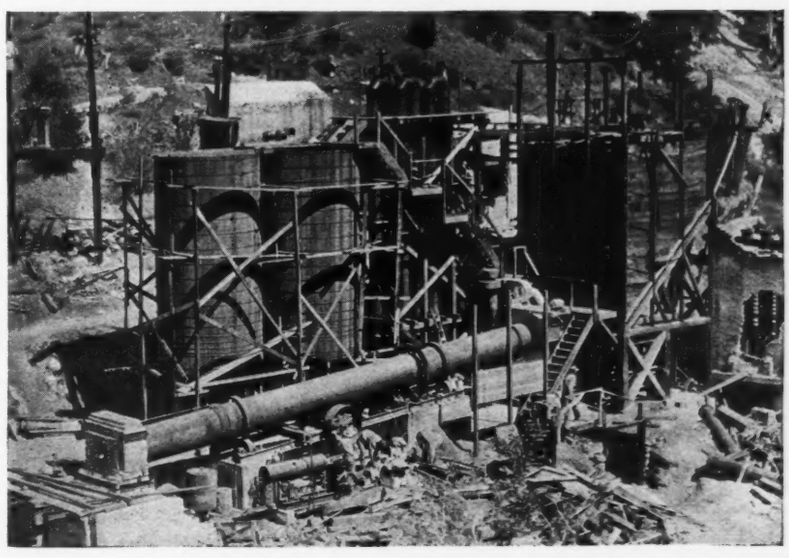
Furnace sizes vary from a small 1½x16-ft. semi-portable unit, handling about 8 tons of ore a day, to one measuring 7x100 ft., or larger, with a capacity of 250 tons. The lining, generally of firebrick, varies in thickness from 4½ to 6½ in. Duschak[7] mentions the use of monolithic linings, made up of a combination of crushed firebrick, 100-mesh firebrick dust, and a quick-hardening cement. This, however, has not proved generally successful.

Feeding of the ore (crushed to an average size of 2 in.) into the furnace is accomplished by a rotating screw, or shaker feed. In order that the ore will remain in the furnace for 1 hr., the speed of rotation of the kiln is limited from 1 to 2 r.p.m. Inclination of the tube—another factor of resistance of the ore in the furnace—in most instances is from 0.5 to 2 in. per foot in length. Fuel oil for firing the furnace varies from 14 to 20 gravity, and is injected with air through an atomizing burner at from 80 to 100 lb. pressure per square inch. The oil generally is preheated to aid its flow and to insure more efficient operation. Air for combustion is heated by passing it over the burned-ore bin. Oil consumption ranges from a little more than 5 to as much as 12 gal. per ton of ore treated, depending on the type and condition of the ore.

Control of temperature and velocity of gasses are important factors in operating a quicksilver furnace. The quicksilver must be removed in the form of a vapor and carried past the dust collector to the condensing system before the temperature drops to a point which will cause condensation. If the temperature is too high, stack losses will be excessive, and if too low, a premature condensation will result, with consequent loss of mercury in the dust collectors. Generally, the heat at the firing end is held to about 650 deg. C., which insures a sufficiently high temperature, about 250 deg. C., through the dust collectors to the condensers. The latter temperature is below the boiling point of quicksilver at atmospheric pressure (357 deg. C.,), but as the gas stream is under a definite vacuum the quicksilver remains in its vapor state.

In 1916, the multiple-hearth furnace was first successfully applied to the reduction of quicksilver ores, when a Herreshoff unit was installed at the Senator mine (New Almaden), in Santa Clara County, Calif. Today there are several such units in operation at quicksilver properties in California. This type of furnace consists, essentially, of a series of superimposed circular hearths sealed fume-tight by an external drying hearth placed on top of the series. The ore is fed by a hopper to the drying hearth and thence into the subsequent hearths, being mechanically advanced through the successive stages by a series of rabbles that revolve slowly about a central shaft. Firing is done at any desired number of hearths, oil usually being burned for fuel through pressure burners. The heat and flame come into direct contact with the slowly moving ore. Calcine is discharged automatically into a burned-ore bin or conveyed directly to the dump. The gasses, including mercury vapor, dust, and combustion byproducts, are drawn off from the top (or any desired) internal hearth, and then pass through the dust collector. As in the other processes, the fumes then pass through

GOULD ROTARY FURNACE (40-ton) and condensing system under construction at Cuddeback mine, Kern County, Calif. An oil-preheating unit can be seen coiled around the furnace near the firing end. Photo by P. L. Blodgett



the condensers, settling tanks, and finally the stack.

The furnace is built in many sizes, with the diameter varying from 4½ to 21½ ft. and with 4 to 6 hearths in the smaller units and up to 16 in the largest. Hearth areas depend both on the diameter and number of hearths, and in larger furnaces they total more than 3,000 sq.ft. Tonnage handled is approximately in proportion to the number of hearths for a given diameter, the average capacity of the furnace being 20 tons per day, although 100-ton units have been installed. Furnaces can be built to handle from 2 to 400 tons of quicksilver ore per day in one unit. The hearths are mostly conical and constructed with firebrick. The walls also are firebrick, and the thickness depends upon the amount of insulation desired. Ore, crushed to 1¼ in. or less, is delivered from a storage hopper to a feed plate on the upper framework of the furnace. From here it is passed in regulated amounts by a feeding knife or cutter onto the drying hearth, whence the ore then continues downward to each successive hearth.

The length of time the ore remains in the furnace depends upon the speed of rotation of the rabble mechanism and the angularity of the rabble teeth. Light fuel oil is generally used for firing, although an installation for the use of butane gas has been made at the Coso quicksilver mine, in Inyo County, Calif. At the Great Western mine, in Lake County, Calif., diesel oil of 27 gravity is being used at present. Air for combustion generally is obtained from a hot-air compartment in the rotating central shaft. An efficient control of temperature is obtainable in this type of furnace because of the ability to use any number of fires at critical points in the furnace, with varying degrees of temperature. As a consequence, the flame temperatures need not be as high, to prevent loss of mercury in the dust collector, in contrast to the use in the rotary furnace.

A parallel comparison of the advantages of the two mechanical furnaces described is impractical, as so much depends on the character of the ore treated and the manner in which each plant is operated. In regards to first cost, the multiple-hearth furnace compares favorably with the rotary, when the comparison is made on a tonnage basis. The nearest approach to a fair comparison was made at the Pershing quicksilver mine, near Lovelock, Nev., where a rotary and a Herreshoff unit operated side by side on the same ore.[8] The latter showed better operating economy than the former, but a certain percentage can be discounted from the fact that 1½-in. crushed ore was screened, the oversize from the ½-in. screen going to the rotary and the undersize being handled by the Herreshoff. The performance shown by the latter to date, at many plants, indicates that it has a real place in quicksilver metallurgy.

Until the advent of the mechanical furnace, the problem of dust was a minor one. Use of brick or concrete chambers for settling dust from the old Scott and other shaft types of furnace was satisfactory. Use of similar devices in rotary kiln operations was unsatisfactory, and until a few years ago constituted a troublesome problem. The objection to dust in the gas stream is that it accumulates in the condenser pipes, impedes the flow of gas, lowers the efficiency of the system, and, perhaps most important of all, forms "soot" and mud, from which it is difficult to separate the quicksilver. It is desirable, therefore, to remove as much dust as possible prior to the gas stream entering the condensers, and at a temperature above the condensation point.

Dust Removal Methods

The first method employed to remove dust from a mechanical furnace was the Cottrell precipitator in connection with the Herreshoff furnace at the Senator mine, mentioned previously. At New Idria baffled concrete and brick chambers with water sprays, immediately following the rotary kilns, were tried. The cyclone dust collector was first introduced to the quicksilver industry at the Knoxville mine, in Napa County, Calif., just prior to 1930, and has since, with various modifications, found almost universal application in mechanical furnace plants. The efficiency of the Sirocco spiral-type cyclone dust collector is good, there being no mechanically moving parts and the velocity of the gas stream itself being the necessary factor for operation. A constant draft through the device is maintained by a motor-driven blower inserted in the system either before or after the collector. Current practice seems to be towards placing the blower after the dust collector to reduce the effect of "sand-blasting." The device consists of an elongated, tapering chamber connected at the bottom with a hopper or similar receptacle for catching the dust. The nearest physical analogy of the principle of the Sirocco dust collector can be found in the effect of tea leaves in a cup of tea when stirred. The rotating motion imparted to the liquid causes the leaves to collect at the center of the cup, the force of gravity causing them to fall to the bottom.

A complete discussion of the principles involved in the condensation of mercury vapor has been thoroughly covered by several authors whose works are readily available.[9] It is deemed sufficient here to state that after the quicksilver has been driven from the ore by heat in a furnace, the resulting vapor must be cooled below the dew point to obtain the metal in its usual liquid form. To do this, a system of condensers is used that must function efficiently to prevent loss of mercury vapor into the atmosphere. Early furnace operations in this country had condensing chambers made from brick or stone, which were followed by concrete structures. In 1917, the United States Bureau of Mines conducted a research on the metallurgy of quicksilver, which was followed by the experimental use and adoption of glazed sewer tile condenser units. Several arrangements were tried, including pipes slightly inclined from the horizontal in the shape of an inverted "V" and in the form of an inverted "U" each with connections at the base. Present practice generally is confined to the latter arrangement, principally because it minimizes clogging from dust and gives easy access for the periodic wash-down and clean-up. The use of sewer tile is being replaced in some instances by metal pipes, and it is in these particulars that the most recent advances in condenser practice have been made. The following types of condenser pipe are now being used at operating plants:

1. Glazed-tile pipe. This material, first used during the years following the World War, is excellent in so far as resistance to corrosive solutions is concerned, but tile pipe is heavy, and as a consequence requires rigid support and care to prevent breaks and cracks. The cooling efficiency is lower than that of metal condensers, mainly because of the thickness of the material necessary for strength.

2. Duriron or Corrosiron. This type of cast iron has a high thermal efficiency as well as high resistivity to corrosion, and is used in a number of plants. Its weight is relatively high. In some cases it is used with tile pipe, being placed near the furnace better to resist the high temperatures.

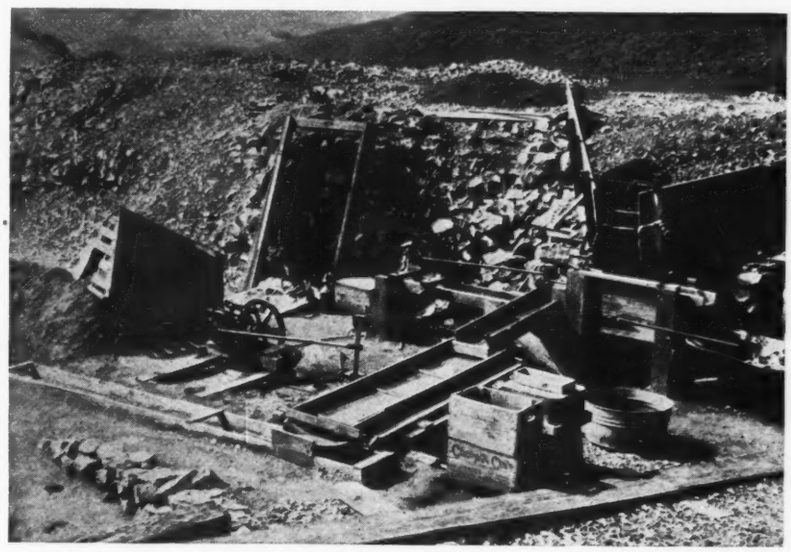
3. Stainless steel. The primary advantage of pipes made from stainless steel in the light weight and thin walls, which result in high cooling efficiency. The resistance of this material to corrosion has not been fully tested under operating conditions. In a few installations, its use has been highly successful, whereas in other plants it is still in the experimental stage.

4. Monel metal. Like stainless steel, Monel metal has the advantage of light weight and high thermal efficiency, in addition to high acid-resisting qualities. Trial installations have shown that the presence of chlorides in the ore will result in the Monel metal pipes being affected. One disadvantage is the expense of the material, which, however, is almost counterbalanced by the apparent advantages it offers over other material used. The few installations in opera-

tion are still in the experimental stage, with insufficient data collected to give a definite answer as to the possibility of its continued use.

Cooling of condenser systems is usually accomplished simply by the normal circulation of air around the exposed pipes. Additional cooling is effected in many cases by external application of water to the pipes. Generally, this is done merely by allowing a continuous film of water to flow down the surfaces of the pipes.

At present fuel oil of varying grades is most generally used, although the wide use of other available fuels such as natural gas and butane gas is not outside the range of possibility in the near future. The use of oil is general, and because previous references to it under the discussion of furnace operation have been numerous, only a few words will be devoted to it here. The grade of the oil averages from 14 to 18 gravity, though some installations use the lighter diesel type of about 25 to 27 gravity. With the use of preheaters, crude oil as low as 9 in gravity is being used at the New Idria mine.



SHAKING SLUICES (hand-made) used for concentrating fines from the old dumps at the St. John's mine, Solano County, Calif.

Natural gas, as a fuel for reducing quicksilver ore, leaves little to be desired. It is clean, burns with almost complete combustion, and has high heating value. However, it is unlikely that natural gas will be used in the quicksilver plants in California for some time, if ever, even though the source of supply is near at hand. The chief obstacle is the first cost of installing the necessary pipe lines to the plants from the nearest available source. Storage at the consuming end of the pipe line is another difficult problem. Although the cost is low, the cheaper rates are based on a quantity consumption guarantee which, by the erratic nature of the quicksilver mining industry, could not in most operations be fulfilled.

The general use of butane gas as a fuel has developed only within the past few years, 1934 being the year in which butane first was adapted to firing a quicksilver furnace. Trial installations were made in the rotary furnaces at the Patriquin mine, in Monterey County, Calif., and the Rinconada, in San Luis Obispo County, Calif., during the latter part of 1934. However, due to several adverse circumstances, the plants were closed down before reliable operating data could be obtained. The only butane installation in a Herreshoff quicksilver furnace in California is at Coso Hot Springs. This construction is in progress at present. From the meager data obtainable, it appears that from 10 to 15 gal. of butane per ton of ore treated was used at the Rinconada mine. A somewhat greater amount was used at the Patriquin mine. In both instances, the excessive consumption of fuel was in part due to improper combustion caused by faulty burner design.

As compared with oil as a fuel, butane gas has several apparent advantages: (1) It is convenient to handle, being clean and easily transported and stored. (2) Combustion is complete, which eliminates the problem of soot formation. (3) None of the excess air required for the combustion of oil is needed in the use of butane, with consequent reduction of burden on the condensers. (4) Butane, being very volatile, requires no air pressure at the burners to atomize the fuel, as is required for oil. (5) Temperature control is possible within narrow limits. The fact that butane is extremely volatile makes for a possible advantage of interest. It naturally volatilizes from a liquid state prior to its ignition at the burners, and this evaporation is accompanied by absorption of considerable heat. This physical characteristic can be made use of in condenser cooling. The plan was successfully tried at the Natomas gold mine about four years ago in connection with a retort to recover quicksilver from amalgam.

The potential heating value of butane is lower than that of oil, but comparison on the basis of efficiency is in favor of butane. Oil of 18 gravity has a potential heating value of 146,800 B.t.u. per liquid gallon, and butane has but 102,000 B.t.u. per liquid gallon. Oil is 50 per cent efficient at best, considering the forced draft required, preheating, and other factors which reduce thermal efficiency. Butane, on the other hand, has a thermal efficiency of at least 90 per cent.[10] The best realized heating value of oil on this basis is 73,400 B.t.u. per gal., as compared with more than 91,000 B.t.u. per liquid gallon for butane. The price of butane is slightly higher than that of oil, the base price (April, 1938) being 4½c. f.o.b. California refineries. At this base rate, any quicksilver district in California can probably be supplied at a price not exceeding 7c. per gal.

The preceding article is a revision of an appendix on the subject included in a comprehensive work on the "Quicksilver Resources of California" by John L. Kellogg and Alfred L. Ransome, the result of a study made in the Department of Mining Engineering at Stanford University, in cooperation with the California State Division of Mines.

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10. Based upon tests on butane-fired fruit driers in California. Information from T. Ransome, Oakland, Calif.

Geophysical Prospecting

Its Part in American Mining

As depicted by the results claimed for work that has been done over two decades in the United States

V. G. Gabriel

Geophysicist and Geologist

DESPITE much writing on the subject of geophysical prospecting, the rôle it has played in the United States in the discovery of ore remains poorly defined. This situation contrasts strongly with that in the petroleum industry of this country, where the value of geophysics to the geologist has been accorded wider recognition.

Proper evaluation of the contributions of geophysical prospecting to mining cannot be made without taking into account certain general conditions and factors prevailing in the mining industry for the last two decades. A study of Fig. 1 and Fig. 2, giving the average prices and production respectively of some of the common metals in the United States in comparison with similar data pertaining to oil, shows that oil, lead, copper, and silver had somewhat similar average price trends from 1918 to 1937 inclusive. However, the trends in yearly production of petroleum on one hand and of metals (copper, lead, silver) on the other hand are very dissimilar. Yearly output of oil increased steadily, with few minor exceptions, from 443,000,000 million barrels in 1918 to 1,278,000,000 million barrels in 1937. Lead, silver, and copper, however, manifested wide variations and certain decreases in yearly production, especially in the intervals from 1919 to 1923 and from 1930 to 1935 inclusive. These variations, coupled with certain unfavorable factors, both national and international in character, and influencing the yearly production of metals in the United States, cannot be considered favorable to the introduction of new and somewhat costly methods in the search for new orebodies and additional geological information.

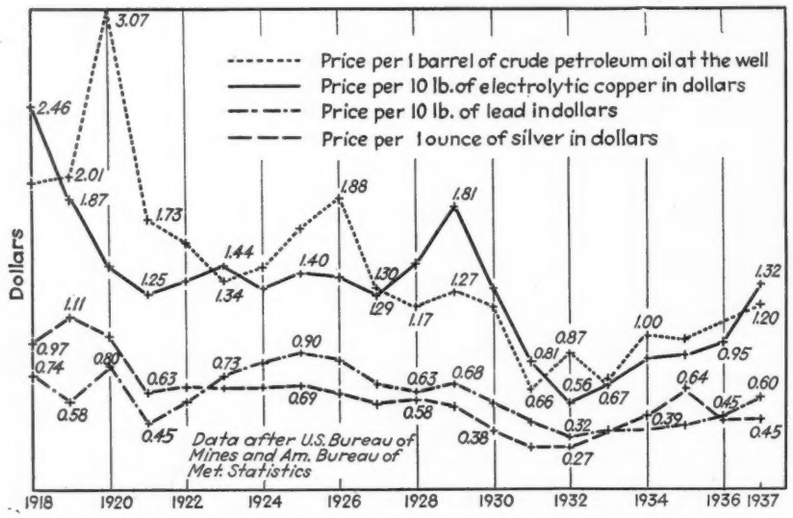
Price per 1 barrel of crude petroleum oil at the well
Price per 10 lb. of electrolytic copper in dollars
Price per 10 lb. of lead in dollars
Price per 1 ounce of silver in dollars
Dollars
Data after U.S. Bureau of Mines and Am. Bureau of Met. Statistics
1918 1920 1922 1924 1926 1928 1930 1932 1934 1936 1937

Fig. 1 . . . Average prices of crude petroleum, copper, lead, and silver, compared. Data after United States Bureau of Mines and American Bureau of Metal Statistics

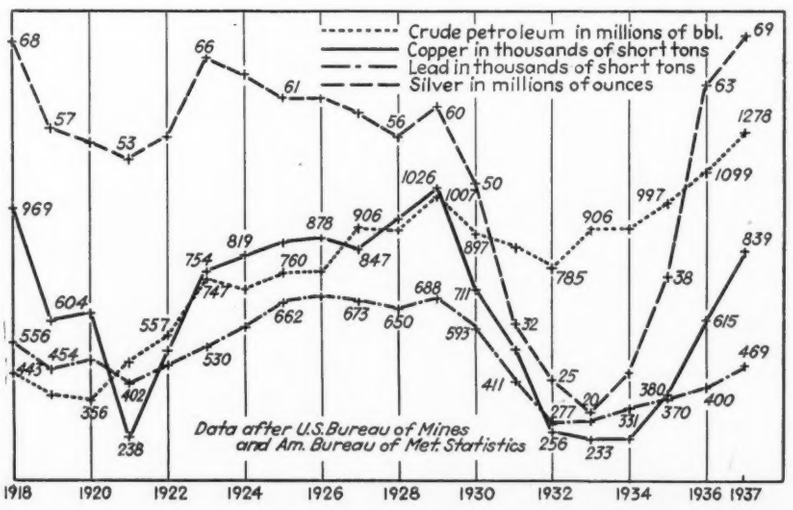
Crude petroleum in millions of bbl.
Copper in thousands of short tons
Lead in thousands of short tons
Silver in millions of ounces
Data after U.S. Bureau of Mines and Am. Bureau of Met. Statistics
1918 1920 1922 1924 1926 1928 1930 1932 1934 1936 1937

Fig. 2 . . . Annual production of crude petroleum, copper, lead, and silver in the United States, compared. Data after United States Bureau of Mines, and American Bureau of Metal Statistics

Use of geophysical methods in exploration for metals in the United States is not an entirely modern phenomenon. It is well accepted that the dip needle was used for locating ores in New Jersey as early as 1760. During the nineteenth century a few State Surveys and scientific workers used magnetic and electrical methods in exploration for metals and for general geological research. Carl Barus in 1882 used a "self-potential" method on the Comstock Lode, in Nevada. He applied the method almost in its recent form. T. B. Brooks in 1873, H. Smock in 1875, and H. L. Smyth in 1899 were using the magnetic instruments to detect iron ores chiefly in the Michigan iron district. In 1893 Professor James Fisher was experimenting with an electric conductivity device to detect copper-bearing lodes at Quincy mine, in Michigan. In 1900 Osborn did some work of rather experimental nature in the Lake Superior Copper Country and on the Mesabi iron range by mapping electric equipotential lines. Gibson, in 1914, made a few successful surveys for gold placers in Butte and Shasta counties, California, with the Thalen-Tiberg magnetometer. In 1915 Hotch-

kiss used the dip needle in exploration for iron deposits in Wisconsin. However, Emmons wrote in 1917:

". . . the exploration of deposits of the metals will never become an exact science. . . . The Cuyuna iron range of Minnesota, which does not exhibit any outcrop of iron ore, was discovered by drilling areas of [magnetic] attraction that are due to belts of magnetic rock associated with the iron ores. . . . In some regions the use of dip needle is justified. There is not much hope of sufficiently developing the gravity method of detecting deposits of heavy ores to make it of practical value."

From 1917 to 1924 the dip needle and the Thalen-Tiberg magnetometer were used in surveying for gold-bearing placers in Alaska and California, for magnetite orebodies in North Carolina and Minnesota, and for copper in Michigan and Wisconsin—all with good results. In 1922 Kelly said:

"A method of electrical prospecting has been developed by Professor C. Schlumberger. . . . I am experimenting with it in this country for the purpose of locating sulphides orebodies by utilizing the fact that the sulphides, in contact with ground water, generate an electric current that may be detected at the surface."

In 1923 John Andersen stated:

". . . The [new] device consists of a high-frequency radio transmitter which is grounded on a sulphide orebody or sulphide exposure somewhere in the mine and a receiver that can detect the sound. . . . Mr. Chilson [the inventor] worked over a property . . . and indicated some large sulphide deposits. . . . He did most of his experimental work on the Mineral Hills Consolidated property, which is a contact metamorphic deposit."

In 1924 the *Engineering and Mining Journal-Press* reported:

"The Empire Zinc Company is using a new method of prospecting at its mines at Hanover, N. M. The method is one worked out by a Swedish engineer, H. Lundberg. . . . The process has been used on the properties of the New Jersey Zinc Company in Wisconsin."

Riley in 1924 wrote:

"A process of locating sulphide orebodies by radio . . . was developed by Daniel G. Gilson at the Bureau of Mines, University of Arizona. . . . The idea of electrically locating orebodies was first conceived by Mr. Gilson in 1904, in Goldfield, Nevada. . . . During the following years tests were made in many camps in California and Arizona, with good results."

However, in spite of some measure of success attained by geophysical exploration in the United States metal industry prior to 1925, Coy and Noble in their report of 1925 on mining methods at the Mascot mines, in Tennessee, stated:

". . . exploration [for zinc sulphide] is carried ahead of mining largely by surface drilling. Both churn and diamond drills are used."

Table I—Electrical Prospecting Methods in the United States Mining Industry Exclusive of Oil Industry

Method	Conducted by	Year of Application	Location	In the Search for	Results Achieved
Self-potential	Carl Barus	1882	Comstock Lode, Nev.	Veins carrying gold and silver minerals	?
Electrical conductivity	James Fisher	1893	Quincy Mine, Michigan	Copper bearing lode, sand stones	Experimental
Equipotential lines	N. S. Osborne	1900	Lake Superior copper district	Copper	Indefinite
Equipotential lines	N. S. Osborne	1900	Mesabi range	Hematite (iron)	Indefinite
Self-potential	S. F. Kelly	1921	Ducktown, Tenn. Wilkes Berre, Pa. Calumet, Mich.	Coal and metal	Of experimental nature
High-frequency radio transmitter	Chilson?	1922	Mineral Hill Consolidated property	Sulphide orebodies	Not known
Inductive	?	1925	Calumet & Hecla, Michigan	Copper	Of experimenta nature
Inductive	Hans Lundberg	1925	Shasta Co., Calif.	For sulphides carrying Cu, Zn, Au.	Successful
Equipotential	Hans Lundberg	1925?	Coeur d'Alene district, Idaho	Galena, sphalerite, some pyrrhotite	Successful
Inductive	Hans Lundberg	1924–28	Gilman, Colo. Hanover and Questa, N. M. Superior and Jerome, Aris. Tintic, Utah	Structures Sphalerite, molybdemite Structure, chalcopyrite Galena and sphalerite	Successful
Electromagnetic	H. R. Conklin	prior 1925	Joplin, Mo.	Galena and sphalerite.	Successful
Self-potential	T. M. Broderick and C. D. Hohl	1927?	Isle Royale Lode, Michigan	Copper	Doubtful
Equipotential	T. M. Broderick and C. D. Hohl	1927?	Isle Royale Lode, Michigan	Copper	Doubtful
Self-potential	T. M. Broderick and C. D. Hohl	1927?	Lodes at Ahmeek, Michigan	Copper	Doubtful
Inductive	T. M. Broderick and C. D. Hohl	1927?	Kearsarge, Pewabic, and Baltic Lodes, Michigan	Copper	Partly successful
Inductive	T. M. Broderick and C. D. Hohl	1927?	Calumet Conglomerate, Champion Mines, Michigan	Copper	Partly successful
Inductive	Hans Lundberg	1928	Upper Mississippi Valley	Zinc and lead	Unsatisfactory
Resistivity	W. O. Hotchkiss, W. J. Rooney and James Fisher	1928	Lake Superior copper region	Copper	Of experimental nature
Inductive	J. J. Jakosky	1928	Inyo Co., California	Sulphide ores	Successful
Equipotential	Swedish American Prospecting Co. and A. Bateman	1929?	Kennecott Mine, Alaska	Chalcocite	Not quite satisfactory
Electromagnetic (Inductive?)	Swedish American Prospecting Co. and A. Bateman	1929?	Kennecott Mine, Alaska	Chalcocite	Not quite satisfactory
High-frequency inductive	Ellis	1930	N. New York zinc district	Sulphides	Adopted for shallow sulphide orebodies
Self-potential	Ellis	1930	N. New York zinc district	Pyrrhotite	Successful
Gish-Rooney	Missouri G. S. under H. A. Buehler	1931	Central Ozark region, Missouri	Iron ores	Successful
Resistivity	?	1931	Michigan	General survey	Successful
Gish-Rooney	Missouri G. S. under H. A. Buehler	1931	Missouri	Bedrocks in connection with Highway Dept.	Successful
Megger Ground Tester	?	1931	Illinois	Water-bearing gravels, faults, structures	Successful
Megger Ground Tester	M. King Hubbert	1932	Illinois	Geologic structures	Successful
Resistivity	?	1932	S. California	Bed rocks and foundation material	Successful
Resistivity	?	1932	Colorado, Michigan, N. Mexico, California, and Texas	Ground water	Successful
Equipotential and electromagnetic	J. J. Jakosky and C. H. Wilson	1933	Trinity Co., Calif.	Gold carrying gravels.	Successful
Electrical	Colorado School of Mines, C. A. Heiland	1933	Colorado	Gold placers	Successful
Ground Comparator	For Solvay Process Co. by S. F. Kelly	1933 and 1934	Near Syracuse, N. Y.	Salt deposit	Unknown
Resistivity	Stanley Wilcox	1934	Minnesota	?	?
Resistivity	?	1934	Iowa	?	?
Resistivity	Missouri G. S. under H. A. Buehler	1934	Missouri	General structures, ores	?
Electrical	U.S. B. of Mines	1934	Ohio	Bed-rock conditions.	Successful
Electrical	U.S. B. of Mines	1934	Nevada	For water- and gold-bearing placers	Fair success
Electrical	Colorado S. of Mines, C. A. Heiland	1934	Colorado	Sulphides, gold-bearing placers	Unknown
Electrical	James Boyd	1934	Colorado	Tungsten deposits, bed rocks	Successful
Resistivity	Schlumberger Co.	1934	California and Alaska	Gold-bearing placers	Unknown
Radiore and resistivity	R. C. Fleming	1934	Nevada	?	?
Ground Comparator	S. F. Kelly, Th. Zuschlog and Bela Low	1934	McDuffie Co., Georgia	Gold-bearing quartz veins	Successful
Resistivity (Gish and Rooney, Wenner)	M. Ewing, A.P. Gray, J. W. Peobles, J. A. Peoples	1934–35	W. Pennsylvania	Anthracite	Successful
Self-potential	Missouri G.S. under H. A. Buehler	1935	S. Missouri?	Pyrite deposits	Unknown
Resistivity	Missouri G.S. under H. A. Buehler	1935	N. Missouri	Study of glacial deposits	Unknown
Resistivity	Schlumberger	1935	U.S.A.	Gold-bearing placers.	Unknown
Resistivity	Missouri G.S. under H. A. Buehler	1936	Missouri	Sulphides, iron ores, fire clay, faults	Successful
Resistivity	U.S. B. of Mines	1936	Texas, Nevada, Hawaiian Is.	Water supply	Fair success
Resistivity (Single point cup electrode)	Gilchris	1936	Tennessee Valley Authority	Bed rocks	Successful
Resistivity	Missouri G.S. under H. A. Buehler	1937	Missouri	General study	?
Resistivity	H. R. Card	1937	U.S.A.	Study of formations.	Of experimenta nature

Arnot in his article on mining methods in the Mother Lode district in California in 1925 wrote: ". . . sinking, drifting, and crosscutting are the methods of exploration now in use." Birch in his report on geology and mining methods of Kennecott Mines, Alaska, published in 1925, stated: "Diamond drilling has been used to good advantage for exploring unknown grounds." Bell wrote, in 1925, "The exploration work is done by crosscutting to the veins and drifting on them," in his report on mining methods of the Telluride district, Colorado.

From 1925 to 1930, inclusive, the inductive methods were used in Arizona, California, Colorado, Michigan, New Mexico, New York, the Upper Mississippi Valley, Utah, and Wisconsin for exploration for copper chalcopyrite, sphalerite, molybdenite, galena, geological and structural problems; the equipotential methods in Idaho, Michigan, Alaska, for exploration for copper, galena, sphalerite, chalcocite, pyrrhotite; and the self-potential method in Michigan and New York for copper and pyrrhotite, all with some success. During the same interval the dip needle and magnetometer were successfully applied in Arkansas, Alaska, California, Colorado, Michigan, Missouri, New York, and Wisconsin for exploration for gold-bearing placers, iron ores, pyrite, pyrrhotite, and geological and structural problems. It is of interest to note that the torsion balance was employed in 1927-28 in the Tri-State field for exploration for zinc and lead orebodies and the seismic refraction method was used in 1930 in Arkansas for the determination of the depths of the old surfaces, both with some measure of success.

From 1931 to 1937, inclusive, various electrical methods were successfully employed in Alaska, California, Colorado, Georgia, Iowa, Michigan, Missouri, Minnesota, Nevada, New Mexico, New York, Ohio, Pennsylvania, Texas, Tennessee, and the Hawaiian Islands for exploration for gold-bearing placers, sulphide orebodies, tungsten deposits, salt deposits, anthracite, ground water, bedrocks, and in the course of various geological and structural studies. Magnetic devices, mostly successful, were applied from 1931 to 1937 in Arizona, Arkansas, Colorado, California, Michigan, Missouri, Nevada, Texas, and the Hawaiian Islands for exploration for bauxite, diamond-bearing peridotites, gold-bearing placers, mineralized inclusions, sulphides, geological and structural studies, and in quarries and water supply problems.

The accompanying tabulations present a record of the published instances of the use of geophysical prospecting methods in the mining industry in the United States. In each case, where possible, the results claimed for the work by those performing it are indicated.

In conclusion, I would repeat that the general decline and the wide variations noticeable in the yearly productions of many useful metals, especially since the year 1929, cannot be considered to furnish an impetus for the wide application of geophysical methods in exploration for orebodies up to 1937. It must be admitted that with a few exceptions the application of geophysical methods to the search for new orebodies in the United States up to the present has often been made in an unsystematic way and usually on a small scale, in spite of success attained in some areas under certain conditions.

Possibly the steady continuation of the upward trend in the yearly production of copper, lead, and other metals since 1935 may stimulate the broader use, for exploration purposes, not only of electric and magnetic methods but to some extent of gravita-

Table II—Magnetic, Seismic, Gravity, and Geothermal Methods of Prospecting in the United States Mining Industry Exclusive of Oil Industry

Method	Conducted by	Year of Application	Location	In Search for	Results Achieved
Dip needle	?	1760	New Jersey	Iron ore	?
Dip needle	John Lock	1846	United States	Tectonic geology	?
Magnetic	T. B. Brooks	1873	Michigan	Magnetic? deposits	?
Magnetic	H. Smock	1875	?	?	?
Magnetic	H. L. Smyth	1899	Michigan	?	?
Dip needle	Hotchkiss	1915	Wisconsin	Iron deposits	?
Thalen-Tiberg magnetometer	A. Gibson	1914	Butte Co., Calif.	Gold-bearing placers.	Successful
Thalen-Tiberg magnetometer	A. Gibson	1914	Shasta Co., Calif.	Gold-bearing placers.	Successful
Dip needle	F. F. Grout and T. M. Broderick	1917	Duluth gabbro, Minnesota	Magnetite	Successful
Dip needle	Calumet & Hecla Mining Co.	1920	Calumet, Mich.	Copper	Successful
Thalen-Tiberg magnetometer	Hamilton?	1918?	Cranberry, N. C.	Magnetite ore veins.	Successful
Thalen-Tiberg magnetometer	A. Gibson	1921	Plumas Co., Calif.	Gold-bearing placers.	Successful
Thalen-Tiberg magnetometer	A. Gibson	1921	Nome, Alaska	Gold-bearing placers.	Successful
Thalen-Tiberg magnetometer	K. C. Laylander	1925	California	Gold-bearing placers.	Successful
Dip needle	H. R. Aldrich	1922	N. Wisconsin	Geology and copper deposits	Partly successful
Dip needle	W.G. and M.I. Survey under H. R. Aldrich	1922–1927	Lake Superior Keweenawan	Geology	Partly successful
Dip needle	T. M. Broderick and C. D. Hohl	1925–1926	Many localities in Michigan copper district	Strikes, folds, fissures, faults	Successful
Schmidt magnetometer	Lake and Buehler	1927–1928	Missouri	Iron ores	Successful
Dip needle	Barron	1928	?	General geology	?
Schmidt magnetometer	C. A. Heiland and W. H. Courtier	1928	Golden, Colo.	Gold-bearing placers.	Some success
Schmidt magnetometer	?	1929	Fairbanks, Alaska	Gold-bearing placers.	Successful
Magnetic	Ellis	1930	New York zinc district	Zinc	Unsuccessful
Magnetic	Ellis	1930	New York zinc district	Pyrrhotite and pyrite	Successful
Hotchkiss dip needle	?	1930	Arkansas	Determination of depths of old surface	Successful
Hotchkiss dip needle	N. H. Stern	1931	Arizona	Mineralized intrusions	Partly successful
Hotchkiss dip needle	N. H. Stern	1931	Arkansas	Bauxite and diamond-bearing peridotites	Partly successful
Schmidt magnetometer	Missouri G.S. under H. A. Buehler	1931	Missouri	Structures, ore bodies	Successful
Magnetic	?	1931	Michigan	General	Successful
Magnetic	Max Mason, L. B. Slichter and B. B. Gauld	1932	?	Quarry	Successful
Schmidt magnetometer	Colorado S. of Mines under C. A. Heiland	1933	Colorado	Gold-bearing placers.	Successful
Magnetic	Michigan S. of M. & T. under J. Fisher	1933	Michigan	Geology and iron ore bodies	Unknown
Schmidt magnetometer	J. J. Jakosky and C. H. Wilson	1933	Trinity Co., Calif.	Gold-bearing gravels.	Successful
Dip needle	C. O. Swanson	1934	N. Michigan	Geology and ore bodies	Successful
Schmidt magnetometer	Colorado S. of Mines under C. A. Heiland	1934	Colorado	Gold-bearing placers.	Unknown
Schmidt magnetometer	Missouri G.S. under H. A. Buehler	1934	Missouri	General study	Unknown
Schmidt magnetometer	Missouri G.S. under H. A. Buehler	1935, '36, '37	Missouri	General study	Unknown
Magnetic	U.S. B. of Mines	1936	Texas, Nevada, Hawaiian Is.	Water supply	Fair success
Seismic					
Seismic (refraction?)		1930	Arkansas	Determination of depths to old surface	Successful
Seismic (refraction and reflection)	B. Gutenberg, H. O. Wood and J. P. Buwalda	1932	S. California	Study of basement rocks	Successful
Seismic					
Seismic (refraction and reflection)	Ewing, Gary and Rutherford, U.S. G. S., U. S. C. & G. S., G. R. C.	1937	U.S.A.	Study of deep sediments	Successful
Gravity					
Eotvos torsion balance	P. W. George and H. A. Guess	1927–1928	Tri-State Field	Zinc and lead ores	Partially successful
Gravity	Ewing, Gary and Rutherford, U. S. G. S., U. S. C. & G. S., G. R. C.	1937	U.S.A.	Study of deep sediments	Successful
Geothermal					
Geothermal measurement	J. Fisher, L. R. Ingersoll and Harry Vivian	1932	Michigan copper district	Measurements so far have been confined to diamond drill holes and to Calumet & Hecla mine	

tional methods on account of their speed and cheapeness attained quite recently.

Success of any geophysical survey for metals for many years to come will depend on not only the very careful selection of a method suitable for the problem under consideration but to a large extent on the close coöperation and mutual understanding between geophysists and geologists. In the final analysis, each mineralized area usually offers a unique combination in composition, relationship, size and depths, which may greatly influence the values of geophysical observations and their interpretations.

I wish to express my thanks to Dr. A. F. Bray, of New York City, for his interest and suggestions.

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Flotation of Silver Minerals Is Studied by Bureau

SILVER-RECOVERY STUDIES recently conducted by the United States Bureau of Mines using synthetic ores are reported upon by E. S. Leaver and J. A. Woolf in Report of Investigation 3436 (Feb., 1939). In general, all of the silver minerals with which tests were made can be floated successfully under the proper conditions; that is, the tests have shown that when the gangue is mostly siliceous and when floating in a normal circuit containing no conditioning agents the recovery of each is high.

Lime in the flotation circuit has little effect upon the recovery of cerargyrite, argentite, polybasite, and tetrahedrite, but usually lowers the grade of concentrate by coagulation of slime. This is especially noticeable when the gangue contains more than the average amount of any kind of slime. The recovery of proustite, pyrargyrite, and stephanite is decreased greatly by the addition of lime to the flotation feed. Inasmuch as lime apparently is not beneficial to the recovery of any of the minerals under investigation, its use in practice should be based upon careful experiment.

Sodium sulphide has a pronounced detrimental effect upon the recovery of all of the silver minerals investigated under the conditions obtaining in these tests; that is, with pure minerals and relatively clean gangue, it is a depressant.

Recovery of cerargyrite is not affected appreciably by the addition of talcy or of clayey iron oxide slime to the flotation feed, but the grade of the concentrate is lowered. Starch can be used successfully to depress a large part of the slime without lowering the recovery of the cerargyrite.

With argentite, the recovery is lowered slightly by the presence of considerable iron oxide slime. This appeared to be due to coating of the argentite particles by the slime. The grade of concentrate also is lowered, but the addition of the correct amount of starch to the flotation circuit remedies the deleterious effect of the slime to a large extent.

Recovery of polybasite, proustite, stephanite, and tetrahedrite is not lowered by the presence of talcy slime in the flotation feed. However, the grade of concentrate invariably is lowered because it is necessary to float a large percentage of the talc to obtain high recovery of the silver minerals. Starch can be used successfully to depress the talc while floating polybasite and tetrahedrite but is not successful with proustite and stephanite, because it acts as a depressant for them.

Pyrargyrite is especially sensitive to any change of condition in the flotation circuit. The presence of talcy slime in the flotation feed lowers both recovery and grade of concentrate. Starch cannot be used successfully to remedy this because of its depressing effect upon the pyrargyrite.

In the flotation of silver minerals in synthetic ores, the relatively pure mineral is mixed mechanically with ground sea sand and other diluents. The mineral therefore is entirely free from the gangue unless it should become coated with the slimy part of the gangue. In the flotation of a natural silver ore, crushing finely enough to liberate the minerals must receive first consideration. This crushing may result in the formation of slime, which may influence the flotation of the silver minerals.

A Quick Repair Job On an Anode Furnace

The log kept is given, showing the progress of the task. Subsequently, 5½ ft. was added to the length to give greater capacity

W. B. Boggs
Smelter Superintendent
Noranda Mines, Ltd.
Noranda, Que.

FROM the beginning of operations at Noranda, Quebec, in 1927 until the end of 1930 all copper made at the Noranda smelter was sent to the United States for refining. In 1930 the decision to build a refinery at Montreal East was made, likewise to make the blister copper into anodes at Noranda. A standard anode furnace was built, using the customary construction of an inverted arch of silica brick for the bottom.

Operation of the furnace began Jan. 20, 1931. About two weeks later, part of the silica brick floated up from the bottom. Finally, on Feb. 28, 1931, a large number of brick came up, and the furnace was shut down so that a new bottom might be installed.

At the time this happened, the matter of furnace bottoms was discussed with F. E. Lathe, of the National Research Council of Canada, and D. W. Stewart, of the Canadian Refractories Company, Ltd. As these men had taken a leading part in the development of a basic refractory in Canada (made from high-lime magnesite), it was decided to follow their suggestions and fuse in a magnesite bottom in the anode furnace in place of the silica brick, using a material manufactured under the trade name of "Magnifrit," made from high-lime magnesite.

The first charge of anodes made in the new bottom was cast in March, 1931, and save for the loss of a few days, consumed in fusing in small patches from time to time, this bottom was in continuous use until September, 1938, during which time 285,310 tons of copper was cast as anodes. During this period, (March, 1931, to Sept. 17, 1938) the fused bottom had been wearing away slowly, until on Sept. 17, clay-brick floaters appeared from the bottom during the poling of the charge. The charge was finished and cast. After the cast a hole was found in the bottom directly below the end of the poles used in refining. This hole was about 6 ft. in diameter and about 30 in. deep, as shown in Fig. 1. After the copper was drained off it was seen that some of the clay brick below the Magnifrit bottom had come up.

An attempt was made to ladle out the copper, but this proved to be slow and laborious. The general foreman, T. McGregor, suggested that a hole be drilled through the concrete base and the furnace bottom at the lowest point of the furnace, as shown in Fig. 1, using a rock drill for the purpose. When the drill penetrated the hot but solid copper, it seized and recourse was had to an iron pipe and oxygen to complete the task. As soon as the pipe and the oxygen reached the molten copper there was a rush of liquid copper into the sand beds previously prepared. About 20 tons of copper ran out. The hole was kept open for some time to allow as much copper as possible to be sweated out of the area surrounding the section to be repaired. When this was accomplished the lower part of the hole was filled in with Ramix up to the top level of the old 13½-in. fireclay brick. This material was thrown in with shovels in successive thin layers and thoroughly dried after each layer.

The remainder of the hole was then filled with a mixture of Magnifrit, roll scale, and Kromepatch cement. The whole furnace bottom was next covered with layers, of about 1 in. thickness, of Magnifrit with 10 to 5 per

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The subject matter here presented was touched briefly on page 79 of the February, 1939, issue, in the article by Mr. Boggs reviewing developments in copper metallurgy in 1938, on which occasion the captions of the drawings were erroneously interchanged. To correct the confusion and at the same time give a fuller account of the repairs and alterations made to the furnace, this article has been prepared.

Table I—Log of Work of Fusing Anode Furnace Bottom Repaired Sept. 19–21, 1938

Date 1938	Time Put In	Mixture: Bags Magnifrit	Mixture: Roll Scale %	Changed Points of Coal: Time	Changed Points of Coal: From To
Sept. 19.....	3:00 p.m.	4	10	7:30–3 p.m.	6
	4:30	4	10	3:00	
	6:00	4	10		
	8:30	2	None		
	8:40	2	None		
	10:00	2	10		
	10:20	2	10		
				11:00 p.m.	6
	11:50	4	10		
	1:10 a.m.	4	10		
	2:45	4	10		
				3:35 a.m.	0
				3:45	6
				3:50	0
				4:00	6
	4:30	4	10		
Sept. 20.....				7:15 a.m.	4
	7:30 a.m.	4	10		
				8:05	6
				9:45	5
	10:15	2	None		
	10:30	2	10		
				11:45	6
	2:30	5	5		
				2:35	4
				3:15	6
	3:20	5	5	3:20	7
	4:15	5	5		
				4:35	6
				4:55	4

Date 1938	Time Put In	Mixture: Bags Magnifrit	Mixture: Roll Scale %	Changed Points of Coa: Time	Changed Points of Coa: From To
				5:25 p.m.	0
				5:30	6
	5:30	4	5		
Sept. 20.....	7:00 p.m.	2	None		
	7:30	2	None		
				7:45	4
	8:00	4	5		
				8:05	6
	9:15	4	5		
	10:45	2	5		
	12:20 a.m.	2	5		
				1:15 a.m.	7
				2:00	6
	3:30	4	10		
	5:05	2	10		
	5:20	2	10		
				6:00	7
	6:30	3	10		
Sept. 21.....	7:10 a.m.	4	10		
				9:30	0
	12:00	Cherry red			
				12:35 p.m.	4
				1:15	5
	2:20 Seasoning copper				
	2:45 Seasoning copper				
				3:15	4
				3:30	3
	3:35 Copper all molten				
				3:45	1
	5:10 p.m. 5 ladles blister				
				6:20	4

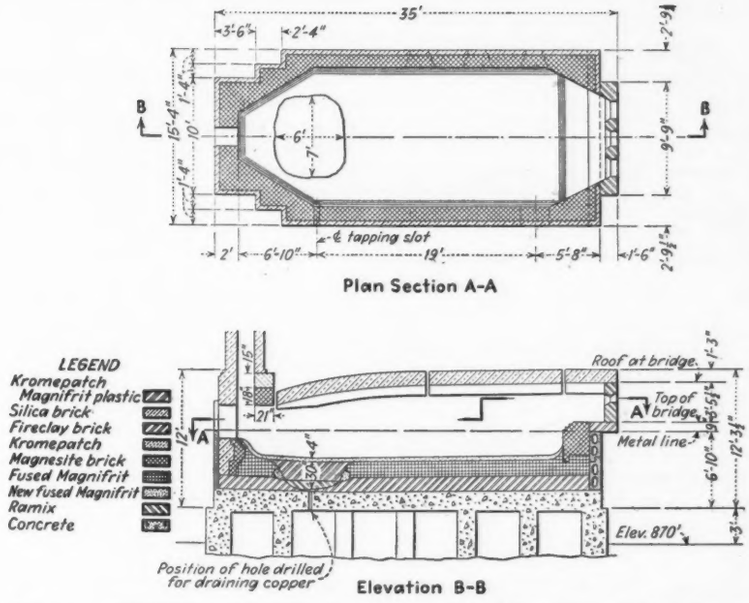

Fig. 1 . . . RREPAIRS to the magnesite bottom of the anode furnace were made as shown here, when a hole about 6 ft. in diameter and 30 in. deep developed after the casting of more than 285,000 tons of copper as anodes

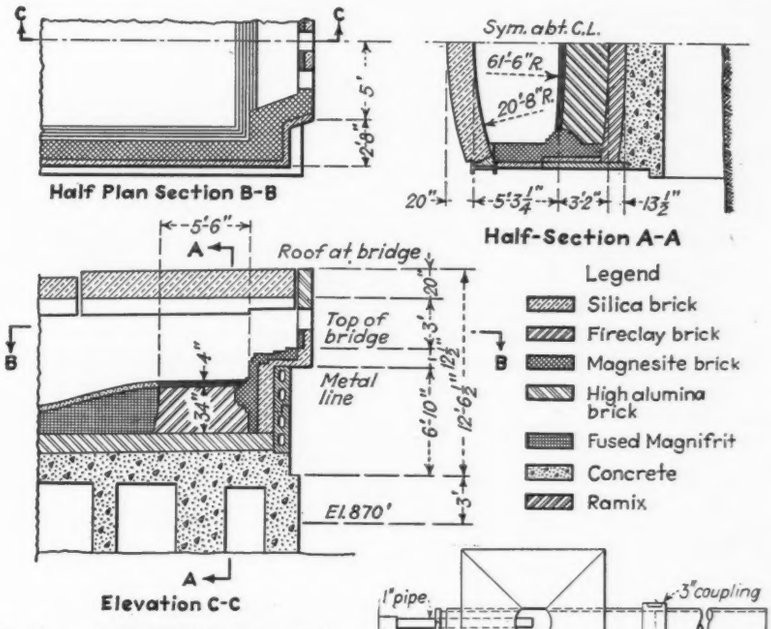

Fig. 2 . . . LENGTHENING of the anode furnace 5½ ft. in the manner indicated was done last November. The details are given in the accompanying text

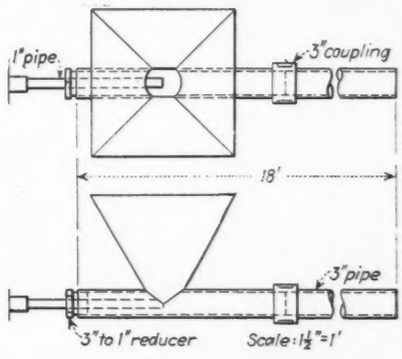

Fig. 3 . . . AN AIR GUN like this was used for placing the fusing material in the furnace at the time of making the repair

cent roll scale and fused. Successive applications were fused until the desired thickness of 4 in. was reached. During the entire operation, from the draining of the copper from the furnace to the final application of Magnifrit, the fire was kept constantly on the furnace.

Table I is a log of the operations of fusing the bottom. Table II shows the chemical analyses of the sample taken from the furnace bottom at the completion of the work. Fig. 3 is a sketch of the air gun used for placing the fusing material in the furnace. The total time used in making the repair as detailed was approximately 60 hours.

Due to an increase in the receipts of copper in custom ores and concentrates, during the latter part of 1938, the anode furnace proved to be too small to handle the production, casting but one charge a day and not casting on Sundays. It was shut down in November, 1938, and 5½ ft. was added to its length.

The concrete base for this extension was built before the furnace was shut down. After the shutdown, the sides, the firing wall, and a 13½-in. inverted arch of fireclay, built inside the walls, were placed on the concrete. Upon the fireclay brick 38 in. of cold Ramix was tamped in successive layers, using a molders' ram for the purpose. When this was completed the roof was built. The details are shown in Fig. 2. Following the brickwork a 4-in. layer of Magnifrit and roll scale was fused on the top of the extended bottom, using the regular procedure of fusion. After fusion of the last layer the furnace was allowed to cool to a cherry red and then brought up in temperature to melt the seasoning copper. When all the copper the bottom would absorb readily was melted, the furnace charge of blister copper was put in and cast the day following the repairs as described.

A charge was made each day for the following two weeks, during which time moisture was dripping from the bottom. At the end of the two weeks a part of the 4-in. layer of fused Magnifrit scaled off from the corners, due undoubtedly to imperfect fusion at these points. The furnace has shown no signs of weakness after three months of continuous operation. The time lost in constructing the extension of the furnace from the time the last charge was cast to charging the furnace was 95 hours.

A fused bottom will crack if allowed to cool sufficiently. These cracks can be closed by firing, as has been done at Noranda and in the steel industry. With this fact established, it is believed by the entire Noranda staff that for a furnace performing even under non-continuous operation, the use of a fused bottom is a big improvement in furnace-bottom construction.

Table II—Chemical Analyses of Core Samples

Taken From Furnace Bottom

Samples	Date Sampled	Cu, %	SiO_2, %	Fe_2O_3, Al_2O_3, %	CaO, %	MgO, %	Remarks
No. 1.....	20–9–38	3.3	12.7	21.2	15.5	47.3	Actual analyses of samples submitted. MgO by difference.
No. 2.....	20–9–38	13.0	5.9	14.5	13.8	52.8	
No. 3.....	20–9–38	0.7	7.6	21.4	13.9	56.4	
Raw Magnifrit..	20–9–38	....	7.4	10.4	16.9	65.3	

Summary of the

MARKETS

MARCH opened on an optmistic note, reflecting increased confidence in the political outlook and the feeling that a seasonal rise in activity was about to set in. Inventories have been reduced and consumers showed more interest in obtaining metals for second-quarter requirements. But confidence waned in the middle of the month as European politics took a turn for the worse and the situation in Washington again became clouded. However, in spite of war scares and domestic politics, the movement of non-ferrous metals into actual consumption in this country was higher in March than in the preceding month. Production and consumption of metals at the end of the month about balanced.

The *E. & M. J.* index of non-ferrous metal prices for March was 77.09, against 76.89 in February and 72.41 in March last year. Lead and tin prices showed higher averages for March.

Domestic sales of copper amounted to 28,678 tons during March, which compares with 20,361 tons in February. Producers felt that the 11½c. Connecticut Valley basis can be maintained until buying in volume develops. Outside metal was not offered so freely and substantial copper orders from Japan helped to relieve pressure. Buying abroad increased to the extent that the Cartel was able to sell its current output.

Lead buying was fairly active and producers raised the price 10 points to the basis of 4.85c., New York. Firmer London prices were a supporting factor.

Zinc was firmer in London, which inspired some buying here, but the price could not be raised, holding at 4½c., St. Louis. Tin production was fixed at 40 per cent of standard tonnages for the April-June quarter and countries that over-exported will cut output even deeper. This news steadied prices.

UNITED STATES MARKET

1939	Electrolytic Copper Domestic (a) Refinery	Electrolytic Copper Export (b) Refinery	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
Mar.						
1	11.025	9.725	46.000	4.750	4.600	4.500
2	11.025	9.725	45.750	4.750	4.600	4.500
3	11.025	9.725	46.000	4.750	4.600	4.500
4	11.025	9.725	46.000	4.750	4.600	4.500
6	11.025	9.775	46.000	4.750	4.600	4.500
7	11.025	9.800	46.000	4.750	4.600	4.500
8	11.025	9.850	46.200	4.750	4.600	4.500
9	11.025	9.950	46.350	4.850	4.700	4.500
10	11.025	9.975	46.400	4.850	4.700	4.500
11	11.025	9.975	46.375	4.850	4.700	4.500
13	11.025	9.925	46.000	4.850	4.700	4.500
14	11.025	9.925	46.100	4.850	4.700	4.500
15	11.025	9.925	46.250	4.850	4.700	4.500
16	11.025	9.875	46.100	4.850	4.700	4.500
17	11.025	9.850	45.875	4.850	4.700	4.500
18	11.025	9.875	45.900	4.850	4.700	4.500
20	11.025	9.875	46.000	4.850	4.700	4.500
21	11.025	9.900	46.125	4.850	4.700	4.500
22	11.025	9.925	45.950	4.850	4.700	4.500
23	11.025	9.925	46.250	4.850	4.700	4.500
24	11.025	9.950	46.625	4.850	4.700	4.500
25	11.025	9.950	46.700	4.850	4.700	4.500
27	11.025	9.975	46.700	4.850	4.700	4.500
28	11.025	9.975	46.500	4.850	4.700	4.500
29	11.025	9.950	46.600	4.850	4.700	4.500
30	11.025	9.975	46.500	4.850	4.700	4.500
31	11.025	9.975	46.500	4.850	4.700	4.500
		AVERAGES FOR MONTH				
	11.025	9.888	46.213	4.824	4.674	4.500
Mar.		**AVERAGES FOR WEEK**				
1	11.025	9.658	45.742	4.750	4.600	4.500
8	11.025	9.767	45.992	4.750	4.600	4.500
15	11.025	9.946	46.246	4.850	4.700	4.500
22	11.025	9.883	45.992	4.850	4.700	4.500
29	11.025	9.954	46.563	4.850	4.700	4.500
Mar.		**CALENDAR WEEK AVERAGES**				
4	11.025	9.713	45.908	4.750	4.600	4.500
11	11.025	9.888	46.221	4.800	4.650	4.500
18	11.025	9.896	46.038	4.850	4.700	4.500
25	11.025	9.921	46.275	4.850	4.700	4.500

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1939	Sterling Exchange "Checks	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
Mar.						
1	4.686250	4.673125	42.750	20.4375	148s 5 d	$35.00
2	4.686250	4.673125	42.750	20.5000	148s 3½d	35.00
3	4.686250	4.673125	42.750	20.5000	148s 4 d	35.00
4	4.686250	4.673750	(e)	20.5000	148s 4 d	35.00
6	4.687500	4.674375	42.750	20.5625	148s 3½d	35.00
7	4.690000	4.677500	42.750	20.5625	148s 2½d	35.00
8	4.688750	4.676250	42.750	20.5625	148s 2½d	35.00
9	4.689375	4.676250	42.750	20.5000	148s 3 d	35.00
10	4.690000	4.677500	42.750	20.6250	148s 3 d	35.00
11	4.690000	4.677500	(e)	20.5625	148s 3 d	35.00
13	4.690625	4.677500	42.750	20.5625	148s 2½d	35.00
14	4.687500	4.673750	42.750	20.6250	148s 3 d	35.00
15	4.683750	4.668750	42.750	20.6250	148s 5½d	35.00
16	4.682500	4.666250	42.750	20.6250	148s 6 d	35.00
17	4.680000	4.659375	42.750	20.2500	148s 6 d	35.00
18	4.677500	4.653750	(e)	20.0000	148s 6½d	35.00
20	4.678750	4.650000	42.750	20.0625	148s 6 d	35.00
21	4.680000	4.656250	42.750	20.0000	148s 5 d	35.00
22	4.680000	4.657500	42.750	19.9375	148s 5 d	35.00
23	4.681250	4.661250	42.750	20.0000	148s 5 d	35.00
24	4.680000	4.661250	42.750	20.0000	148s 5 d	35.00
25	4.680000	4.660000	(e)	20.0000	148s 5 d	35.00
27	4.680000	4.660000	42.750	19.9375	148s 5½d	35.00
28	4.680000	4.660000	42.750	19.9375	148s 5½d	35.00
29	4.680000	4.657500	42.750	19.8750	148s 6 d	35.00
30	4.678750	4.655625	42.750	19.8750	148s 6½d	35.00
31	4.678750	4.655625	42.750	19.9375	148s 6½d	35.00
Average for Mo.	4.68370	.....	42.750	20.280	.....	35.00
		AVERAGES FOR WEEK				
Mar.						
1	4.68906	.....	42.750	.....	.....	.....
8	4.68750	.....	42.750	.....	.....	.....
15	4.68854	.....	42.750	.....	.....	.....
22	4.67979	.....	42.750	.....	.....	.....
29	4.68021	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver March 4th, 42.750; 11th, 42.750; 18th, 42.750; 25th, 42.750.

(e) Not quoted; Saturday.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.325c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1939, the U. S. Government's price on newly mined domestic silver was continued at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout March.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1939	COPPER			TIN		LEAD				ZINC			
	Standard		Electro	Standard		Spot		3 months		Spot		3 months	
Mar.	Spot	3 months	Bid	Spot	3 months	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers	Buyers	Sellers
1.....	42.3125	42.6250	47.5000	214.7500	214.2500	14.2500	14.3125	14.4375	14.5625	13.5625	13.6250	13.8125	13.9375
2.....	41.9375	42.2500	47.5000	214.2500	213.5000	14.1875	14.2500	14.3750	14.4375	13.6250	13.6875	13.8750	13.9375
3.....	42.1250	42.3750	47.5000	214.3750	213.7500	14.3125	14.3750	14.5000	14.5625	13.5625	13.6250	13.8750	13.9375
6.....	42.8750	43.1875	48.0000	214.7500	214.5000	14.4375	14.5000	14.6875	14.7500	13.6875	13.7500	13.9375	14.0000
7.....	42.7500	43.0625	47.5000	215.0000	214.2500	14.3125	14.3750	14.5625	14.6250	13.5625	13.6875	13.8750	13.9375
8.....	43.3125	43.6250	48.5000	215.5000	215.0000	14.6250	14.6875	14.9375	15.0000	13.8125	13.8750	14.0625	14.1250
9.....	43.5625	43.8750	48.5000	216.7500	215.7500	14.7500	14.8125	15.0000	15.0625	13.8750	13.9375	14.1875	14.2500
10.....	43.3125	43.6250	48.5000	216.2500	215.5000	14.8750	14.9375	15.1250	15.1875	13.8750	13.9375	14.1250	14.1875
13.....	43.1875	43.4375	48.0000	215.7500	215.0000	14.8125	14.8750	15.0625	15.1250	13.8750	13.9375	14.1250	14.1875
14.....	43.2500	43.5000	48.0000	215.5000	214.7500	14.8125	14.8750	15.1250	15.1875	13.8125	13.8750	14.0625	14.1250
15.....	43.5000	43.7500	48.2500	216.2500	215.5000	14.9375	15.0000	15.1875	15.2500	13.8125	13.8750	14.0625	14.1250
16.....	42.6250	42.8125	47.7500	215.0000	214.3750	14.6250	14.6875	14.8750	14.9375	13.6250	13.6875	13.8750	13.9375
17.....	42.3750	42.6875	47.7500	213.5000	213.0000	14.6250	14.6875	14.8750	14.9375	13.5625	13.6250	13.8125	13.8750
20.....	42.6250	42.9375	48.0000	214.7500	213.7500	14.6250	14.6875	14.8125	14.8750	13.6250	13.6875	13.8125	13.8750
21.....	43.0625	43.3750	48.2500	215.5000	214.5000	14.9375	15.0000	15.0625	15.1250	13.8750	14.0000	14.0625	14.1250
22.....	42.9375	43.1875	48.2500	214.2500	213.5000	14.8750	15.0000	15.0625	15.1250	13.6875	13.7500	13.9375	14.0000
23.....	42.8750	43.1250	48.2500	215.0000	214.0000	14.7500	14.8125	14.8750	14.9375	13.7500	13.8750	13.9375	14.0000
24.....	43.0000	43.2500	48.2500	217.0000	215.2500	14.8125	14.8750	14.9375	15.0000	13.6875	13.8125	13.9375	14.0000
27.....	43.3750	43.6250	48.5000	217.0000	215.7500	14.8125	14.8750	14.8750	15.0000	13.6875	13.8125	13.8750	14.0000
28.....	43.1250	43.4375	48.5000	216.0000	214.7500	14.6875	14.7500	14.8125	14.8750	13.6875	13.8125	13.8750	13.9375
29.....	43.0625	43.3125	48.5000	215.7500	214.5000	14.5625	14.6250	14.7500	14.8125	13.6250	13.6875	13.8750	13.9375
30.....	43,1875	43.4375	48.5000	215.7500	214.5000	14.5000	14.5625	14.6250	14.6875	13.5000	13.6250	13.7500	13.8125
31.....	43.1875	43.4375	48.5000	215.0000	213.7500	14.3125	14.3750	14.4375	14.5000	13.4375	13.5000	13.5625	13.6250
Average for month..	42.938	.....	48.120	215.375	.....	14.660		14.860		13.728		13.961	

Prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers prices. All are in pounds sterling per long ton of 2,240 lb.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(April 1, 1939)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb ..... 20c.
Antimony, domestic, spot, lb ..... 11.500c.
Bismuth, ton lots, lb $1.10
Cadmium, commercial sticks, lb ..... 50c.
Calcium, lb., ton lots 97 @ 98 per cent ..... 75c.
Chromium, 97 per cent grade, lb ..... 85c.
Nickel, electrolytic cathodes, lb ..... 35c.
Magnesium, 99.8 per cent, carolads, lb ..... 28c.
Palladium, troy oz $24.00
Platinum, (Official quotation) troy oz $35.00
Quicksilver, flask of 76 lb., 100 flasks or more ..... $88.00@$90.00
Radium, mg. radium content $40.00
Selenium, 99.5 per cent, lb $1.75
Silicon, minimum 97 per cent, spot, lb ..... 16.50c.
Tellurium, lb $1.75
Thallium, 100 lb. or more, lb $6.50
Titanium, 96 to 98 per cent, lb $5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton ..... $30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton ..... $22.00@$23.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:
Old Range bessemer $5.25
Mesabi bessemer $5.10
Old Range non-bessemer $5.10
Mesabi, non-bessemer $4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton $54.38
Manganese Ore, c.i.f. Atlantic ports, long ton unit:
52 @ 55 per cent ..... 29c.
50 @ 52 per cent ..... 28c.
44 @ 48 per cent ..... 24c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2 ..... 45c.
Tungsten Ore, per unit of WO_3:
Chinese, 65 per cent, duty paid $19.00
Domestic, 65 per cent and upward ..... (a)$16.00@$18.00
Vanadium Ore, per lb. of contained V_2O_5 ..... 27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton $30.00
(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb 3c
Cobalt Oxide, 70 @ 71 per cent, lb ..... $1.67@$1.77
Copper Sulphate, 100 lb $4.50
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb $1.42
Sodium Sulphate, bulk ton ..... $13.00@$15.00

ALLOYS

Berryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be $23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb ..... 10½c.
Ferromanganese, 78 @ 82 per cent, gross ton $80.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained ..... 95c.
Ferrosilicon, 50 per cent, gross ton $69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained $1.65

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:
Canadian (Quebec)
Crude No. 1 ..... $700@$750
Crude No. 2 ..... $150@$350
Spinning fibers ..... $110@$200
Paper stock ..... $40@$45
Shorts ..... $12@$16.50
Vermont
Shingle stock $57
Paper stock $40
Cement stock $25
Barytes, long ton:
Georgia, crude $7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron ..... $6.00@$7.00
Bauxite, long ton:
Domestic, chemical, 55 @ 58 per cent ..... $6.00@$7.00
Domestic, abrasive, 80 @ 84 per cent ..... $12.00@$14.00
Dalmatian, 50 @ 55 per cent ..... (a)$6.00@$7.00
French, 56 @ 59 per cent ..... (a)$7.00@$8.00
China Clay, f.o.b. mines, ton:
South Carolina and Georgia, No. 1, bulk ..... $6.75@$8.00
Delaware, No. 1 ..... $14.50
Feldspar, bulk, ton:
Potash feldspar, 200 mesh $17.00
Glass-spar, white, 20 mesh $11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton $18.00
Fuller's earth, f.o.b. Georgia or Florida, ton ..... $7.00@$14.00
Magnesite, per ton:
Dead-burned, f.o.b. California $25.00
Dead-burned, f.o.b. Washington $22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:
1½ x 2 in ..... 15@35c.
2 x 2 in ..... 30@50c.
3 x 3 in ..... 75@$1.00
3 x 4 in ..... $1.00@$1.30
4 x 6 in ..... $2.00@$2.50
White, ground, 70 mesh, ton ..... $60.00@$80.00
Ocher, Georgia, ton ..... $19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports ..... (a) 12@12½c.
Silica, in bags, 325 mesh, ton ..... $18.00@$40.00
Sulphur, Texas mines, long ton $16.00
Talc, f.o.b. works, ton:
New York, double air-floated, 325 mesh ..... $12.00@$15.00
New Jersey, mineral pulp ..... $8.00@$10.00
Vermont, extra white, 200 mesh ..... $9.00@ $9.50
Tripoli, Missouri, ton:
40 mesh, cream colored $14.50
200 mesh, cream colored $26.00
(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:
Bessemer $21.50
Basic $20.50
No. 2 Foundry $21.00
Steel, base prices, Pittsburgh:
Billets, gross ton $34.00
Structural shapes, 100 lb $2.10
Bars, 100 lb $2.25

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1938	1939	1938	1939	1938	1939
January	44.750	42.750	19.895	20.305	499.895	466.775
February	44.750	42.750	20.159	20.370	501.722	468.472
March	44.446	42.750	20.088	20.280	498.394	468.370
April	42.750	.....	18.880	.....	498.046	.....
May	42.750	.....	18.731	.....	496.673	.....
June	42.750	.....	18.945	.....	495.772	.....
July	42.750	.....	19.356	.....	492.855	.....
August	42.750	.....	19.389	.....	488.044	.....
September	42.750	.....	19.300	.....	480.240	.....
October	42.750	.....	19.613	.....	476.785	.....
November	42.750	.....	19.834	.....	470.587	.....
December	42.750	.....	20.083	.....	466.798	.....
Year	43.225	.....	19.523	.....	488.818	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1938	1939	1938	1939	1938	1939	1938	1939
January	10.198	11.025	9.908	9.912	41.387	43.125	45.387	48.440
February	9.775	11.025	9.525	9.735	39.597	42.188	43.563	47.375
March	9.775	11.025	9.496	9.888	39.772	42.938	43.582	48.120
April	9.775	.....	9.443	.....	39.306	.....	43.408	.....
May	9.375	.....	8.801	.....	36.668	.....	40.852	.....
June	8.775	.....	8.500	.....	35.235	.....	39.417	.....
July	9.585	.....	9.573	.....	39.744	.....	44.405	.....
August	9.900	.....	9.844	.....	40.591	.....	45.909	.....
September	10.028	.....	9.943	.....	41.864	.....	47.148	.....
October	10.760	.....	10.713	.....	45.646	.....	51.190	.....
November	11.025	.....	10.569	.....	45.244	.....	51.080	.....
December	11.025	.....	10.023	.....	43.428	.....	48.988	.....
Year	10.000	.....	9.695	.....	40.707	.....	45.411	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1938	1939	1938	1939	1938 Spot	1938 3 mos.	1939 Spot	1939 3 mos.
January	4.870	4.826	4.720	4.676	16.135	16.253	14.534	14.744
February	4.632	4.805	4.482	4.655	15.402	15.525	14.283	14.417
March	4.500	4.824	4.350	4.674	15.992	16.075	14.660	14.860
April	4.500	.....	4.350	.....	15.579	15.623	.....	.....
May	4.400	.....	4.250	.....	14.210	14.376	.....	.....
June	4.148	.....	3.998	.....	13.969	14.012	.....	.....
July	4.882	.....	4.732	.....	14.921	15.034	.....	.....
August	4.900	.....	4.750	.....	14.371	14.480	.....	.....
September	4.998	.....	4.848	.....	15.249	15.401	.....	.....
October	5.100	.....	4.950	.....	16.173	16.313	.....	.....
November	5.091	.....	4.941	.....	16.088	16.223	.....	.....
December	4.842	.....	4.692	.....	15.106	15.275	.....	.....
Year	4.739	.....	4.589	.....	15.266	15.383	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1938	1939	1938	1939
January	41.548	46.404	183.619	215.435
February	41.373	45.640	183.144	213.906
March	41.219	46.213	183.473	215.375
April	38.430	.....	168.612	.....
May	36.885	.....	162.693	.....
June	40.376	.....	177.429	.....
July	43.428	.....	192.542	.....
August	43.276	.....	192.966	.....
September	43.369	.....	193.733	.....
October	45.263	.....	206.911	.....
November	46.262	.....	213.909	.....
December	46.180	.....	214.450	.....
Year	42.301	.....	189.457	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1938	1939	1938 Spot	1938 3 mos.	1939 Spot	1939 3 mos.
January	5.000	4.500	14.994	15.173	13.682	13.887
February	4.813	4.500	14.408	14.589	13.522	13.780
March	4.417	4.500	14.364	14.477	13.728	13.961
April	4.141	.....	13.729	13.919	.....	.....
May	4.042	.....	12.682	12.869	.....	.....
June	4.131	.....	12.890	13.104	.....	.....
July	4.745	.....	14.144	14.371	.....	.....
August	4.750	.....	13.467	13.675	.....	.....
September	4.846	.....	14.040	14.246	.....	.....
October	5.012	.....	15.083	15.232	.....	.....
November	4.924	.....	14.366	14.550	.....	.....
December	4.500	.....	13.709	13.861	.....	.....
Year	4.610	.....	13.990	14.172	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium			Aluminum	
	1938 (a)	1939 (a)	1939 (b)	1938	1939
January	117.500	70.900	58.400	20.000	20.000
February	117.500	67.500	55.000	20.000	20.000
March	117.500	65.278	54.259	20.000	20.000
April	102.500	.....	.....	20.000	.....
May	102.500	.....	.....	20.000	.....
June	102.500	.....	.....	20.000	.....
July	102.500	.....	.....	20.000	.....
August	99.722	.....	.....	20.000	.....
September	84.000	.....	.....	20.000	.....
October	80.000	.....	.....	20.000	.....
November	77.717	.....	.....	20.000	.....
December	72.500	.....	.....	20.000	.....
Year	98.037	.....	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound; (a) average of producer's and plater's quotations; (b) producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1938	1939	1938	1939	1938	1939
January	13.750	11.670	79.240	77.440	36.000	34.440
February	13.750	11.250	76.455	85.227	36.000	35.000
March	13.750	11.269	72.444	87.278	36.000	35.000
April	13.654	.....	71.019	.....	36.000	.....
May	12.460	.....	74.640	.....	33.400	.....
June	11.731	.....	80.731	.....	33.231	.....
July	11.030	.....	76.860	.....	36.000	.....
August	10.880	.....	75.500	.....	37.000	.....
September	11.310	.....	74.420	.....	39.000	.....
October	12.060	.....	73.480	.....	37.960	.....
November	12.250	.....	74.065	.....	36.217	.....
December	11.567	.....	76.769	.....	34.000	.....
Year	12.349	.....	75.469	.....	35.901	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk deduct .250c. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum is dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1938	1939	1938	1939	1938	1939
January	24.50	21.50	23.50	20.50	24.00	21.00
February	24.50	21.50	23.50	20.50	24.00	21.00
March	24.50	21.50	23.50	20.50	24.00	21.00
April	24.50	.....	23.50	.....	24.00	.....
May	24.50	.....	23.50	.....	24.00	.....
June	23.73	.....	22.73	.....	23.23	.....
July	20.50	.....	19.50	.....	20.00	.....
August	20.50	.....	19.50	.....	20.00	.....
September	20.50	.....	19.50	.....	20.00	.....
October	21.50	.....	20.50	.....	21.00	.....
November	21.50	.....	20.50	.....	21.00	.....
December	21.50	.....	20.50	.....	21.00	.....
Year	22.686	.....	21.686	.....	22.186	.....

Iron, dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

R. G. Lemmon is making a short visit to Australia.

G. S. Brooks is in London on mining business for the Trepca and Giesche properties.

C. J. Calvin, chief engineer for the Great Northern Iron Ore Properties, Hibbing, Minn., is vacationing in Bermuda.

G. B. Blonsky, mining engineer, San Francisco, has been appointed mine superintendent for Operator Consolidated Mines Company at Johannesburg, Calif.

David Segura has become chief of the mines department of the Ministry of National Economy of Mexico, succeeding **Andres Manning,** who retired recently.

A. C. Ensign has been appointed superintendent of the Magna concentrator of the Utah Copper Company and **C. B. Ashby** assistant superintendent.

Jack Sandberg, formerly with Wesko Mines, Ltd., at Ymir, B. C., is now in charge of the 50-ton mill of Spud Valley Gold Mines, Ltd., at Zeballos, B. C.

P. E. Peterson left Vancouver, B. C. in March for South America, where he will investigate mining investment opportunities.

R. J. H. Mittwer has been elected president of the Pacific Mineral Society of Los Angeles, succeeding **Victor M. Arciniega.**

J. F. Thorn, general manager of Lake View & Star, Ltd., returned to Australia in February from a visit to Great Britain and the United States.

J. A. Little has been appointed general manager of Normetal Mining Corporation, Ltd., the former manager, **R. R. Basserman,** having been made consulting engineer for the company.

Frederic Benard has become assistant to the general superintendent, mining and smelting division, of the International Nickel Company of Canada, Ltd., at Copper Cliff, Ont.

K. P. W. Parsons, formerly on the metallurgical staff of New Occidental Gold Mines, N. L., Cobar, N. S. W., recently joined the staff of The Zinc Corporation, Ltd., Broken Hill.

B. H. Thorne was elected president of the Canadian Institute of Mining and Metallurgy at the annual meeting of the Institute at Quebec last month. He succeeds **E. A. Collins,** of International Nickel Company of Canada, Ltd.

Francis R. Pyne, metallurgical engineer, has become associated with the Irvington Smelting & Refining Works, Irvington, N. J., as assistant superintendent. The omission of the word "assistant" in the item in the March issue was caused by an error in transcription.

T. M. Carey, chief engineer of The Zinc Corporation, Ltd., returned to Broken Hill recently after a tour abroad covering nine months which included visits to the United States, Canada, Europe, and Africa.

Dr. Patrick Marshall, geological adviser to the New Zealand Government, and formerly professor of geology at Otago University, is president- elect of the Australian and New Zealand Association for the Advancement of Science.

Dr. E. T. McKnight, geologist for the United States Geological Survey, who has spent the past four years in the Tri-State district, returned to Washington, D. C., early in March. Dr. McKnight has been carrying on the incompleted work of the late Dr. C. E. Siebenthal.

W. V. Burley, of Chicago, who succeeded the late James A. Caselton as manager of the St. Louis division of the National Lead Company, was in the Tri-State district early in March to visit the properties of the St. Louis Smelting & Refining Company, which is a subsidiary of the Lead Company.

Dr. Rene Engel is responsible for the information that some space will be given to non-ferrous metals on the program of the Western Chemical Congress, which is to be held at the Fairmont Hotel, in San Francisco, Aug. 6 to 12. The objective of the Congress is to focus attention of the public upon the potentialities of the West in respect to chemical process industries.

O. C. Ralston, chief engineer of the non-metals division of the United States Bureau of Mines, on March 28 delivered a lecture in the University of Maryland-Bureau of Mines series in the College of Engineering auditorium at College Park, Md. An exhibit of unusual industrial minerals was shown and discussed by the representative of the Bureau. The lecture was open to the public.

Bernard Manderfield has been appointed superintendent of the Champion mine for the Copper Range Company, Painesdale, Mich. For the past two years he has been chief engineer. **Paul Redeker,** formerly superintendent of the Baltic mine and later mine captain at the Champion, has left the Copper Range Company to become superintendent of the Isle Royale mine, succeeding **Lucien Eaton.** Mr. Eaton has resigned to return to private practice.

Oliver Hall, consulting engineer for Noranda Mines, Ltd., was on March 14 awarded the platinum medal of the Canadian Institute of Mining and Metallurgy "as a mark of distinction and recognition to the person who has made a meritorious and practical contribution of outstanding importance to the mining and metallurgical industry of Canada."

O. D. McClure, of Ishpeming, Mich., chief mechanical engineer for the Cleveland-Cliffs Iron Company and general manager of the Cliffs Power & Light Company, retired on April 1 from active duty. **L. C. Moore,** formerly mechanical engineer for the company on the Mesabi range, has succeeded him as chief mechanical engineer, with headquarters at Ishpeming. **J. D. Preston** has become manager of the Cliffs Power & Light Company.

Harlan A. Walker has been appointed assistant general manager of the Homestake Mining Company at Lead, S. D. For the last two and a half years Mr. Walker has been assistant general manager of the El Potosi Mining Company, the Mexican subsidiary of the Howe Sound Company operating in Chihuahua, Mexico. He is a graduate of the University of Utah and subsequently studied a year at Columbia. Before going to Mexico he worked in various places in Utah, Nevada, and Colorado. His first position with the El Potosi company was that of engineer, after which he served as superintendent until his appointment as assistant general manager.

OBITUARY

Ernest Hallberg, formerly a diamond drilling contractor, died March 2 in Mexico City after a brief illness. He was 51 years old.

F. S. Cowden, mining engineer, long active in the Grass Valley mining area of California, died recently at Berkeley, Calif., at the age of 76.

R. J. Pearce, one-time superintendent of the New Almaden quicksilver mines near San Jose, Calif., died at his home in San Jose. He was 72 years old.

James W. Hunter, for 32 years superintendent of the diamond-drilling division of E. J. Longyear Company, with headquarters at Minneapolis, Minn., died on March 5 at Akron, Ohio, at the age of 63.

Stanley N. Rodda, principal of the Melbourne Technical College from 1914 to 1928, when he resigned to take up consulting work, died at Mount Dandenong, Victoria, on Jan. 16, aged 61 years.

Williams Ebenezer Ford, professor of mineralogy at Yale and a member of the faculty of that University for 40 years, died in New Haven, Conn., on March 23 at the age of 61.

John Evans Bergh, a mining engineer for the United States Smelting, Refining & Mining Company, and long identified with the industry in the Intermountain mining country, died at Salt Lake City, Utah, on March 12 from peritonitis following an operation. He was 58.

Frank J. Uhte, a well-known mill and smelter designer, died recently at Carlsbad, N. M. He was associated with the American Potash & Chemical Company and formerly has been with Nevada Consolidated, Phelps Dodge, Hudson Bay Mining, and Utah Copper.

Sir Edmund Davis, one of the outstanding personalities of African mining, died in England on Feb. 20, aged 76. He was a director of 39 companies and chairman of 19, all but two or three of which were engaged in mining operations and in handling mineral lands in Africa. In recent years he had been active in the development of Northern Rhodesia's copper, being a director of the British South Africa Company, Rhokana Corporation, Rhodesian Anglo American, and vice-chairman of the last named. He was also chairman of Rhodesia Broken Hill Development Company and Wankie Colliery Company. Sir Edmund was heavily interested financially in chrome mining in Southern Rhodesia and in the chrome districts of New Caledonia.

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Letters

Dry Crushing and Intersticial Cyanidation

The Editor:

IN CITING the following, I trust the lapse of time will absolve me from being accused of violating professional ethics between client and engineer without the consent of the principal.

When gold extraction by the use of cyanide was in its infancy, in fact before the process got on its legs, I followed the urge of trying out "the new." In my report to the Hidalgo Mining Company, which sent me to Mexico in December, 1903, to investigate the cause of the company's failure with the chlorination process, I concluded as follows:

"I recommend, after having made a large number of tests and assays, that $50,000 be raised to follow up my laboratory experiments with a practical pilot milling plant using potassium cyanide as the basic solvent, for by this method I obtained, on samples of one to two hundred pounds, extractions of gold and silver as follows on ore taken from the:

	Per Cent Extraction (by Difference)
Preseña Mine run	82
Preseña Mine dump	84
Morana Mine	84
Los Guijas Mine	90
Cabadeña Mine	70
San Juanico Mine	92

My recommendation was not adopted and the enterprise was abandoned. The mines were closed for several years, but later were taken over by a large progressive company, and voila! have since been a pronounced success with the present standard cyanide process.

What has that to do with "intersticial cyanidation"? Nothing as is, yet apparently everything as was. A basic something I failed to recognize at the time in my month or more of crude experiments on the ground.

Subjecting this month or more of work to retrospection, I now find that my crude tests, performed by cutting a whiskey barrel in half, dry crushing my samples by hand to about ¼ in. and finer, adding KCN and allowing the batch to stand before washing by decantation, produced results (by difference between the heads and tails) as cited above, which I copy from my original report dated Feb. 2, 1904. A result, the importance of which I now realize, resurrect, and combine with up-to-date metallurgical technology.

As to the correctness of the assays made by myself in the Hidalgo company's laboratory, I personally have no doubt, for I had for years been assayer and chemist for the largest smelter in Colorado, of which I later became the manager.

I am reviving and revising experiences of a generation or more ago by advocating their repetition based upon existing mechanical methods now in vogue, but unknown at the time of my experiments.

Experience in the use of cyanide has shown that oxygen is absolutely necessary in the conversion of metallic gold in the gangue to gold in solution, and back to metallic gold in the bar.

In regard to this matter of oxidation, I quote the following from an article by the late H. Vincent Wallace, chief metallurgist of the Wright-Hargreaves mine, Kirkland Lake, Ontario, printed in December, 1932, the first paragraph of which reads:

"Although it is universally accepted that free oxygen is necessary in a cyanide solution for the dissolution of gold and silver—in accordance with Elsner's equation that $2Au+4KCN+O+H_2=2KAu(CN)_2+2KOH$ —little has been written and insufficient attention paid to the drop in extraction due apparently to loss of dissolved oxygen in mill solutions."

Another feature of prime importance is the fact that 25 per cent less metallic iron is consumed in dry grinding than in wet grinding, with consequent saving of both cyanide and free oxygen consumed in converting an excessive amount of iron to ferrocyanide in advance of the formation of gold cyanide.

In another part of Mr. Wallace's article he very aptly refers to this abraded iron as an "oxygenicide" and asks for comments. To this I replied at the time, outlining a method for reducing this abraded metallic iron and increasing the amount of free oxygen through exceptional agitation of the mass undergoing disintegration, with the consequent association of the free oxygen in the accompanying air.

In fine wet crushing in any ball or pebble mill, free oxygen is soon reduced to a minimum and is restricted in its combination with the KCN due to the coating of the crushed ore particles with the accompanying liquid conveyor.

Now my question is, why depend upon the minute quantity of free oxygen accompanying the H_2O, used primarily as a conveyor, which fills the interstices of the crushed ore, when by crushing dry the interstices are filled by the 20 per cent or more of free oxygen in the air which activates the combination of cyanide and gold? I'll admit my ideas may be drying up and may need the addition of a lubricant to the gray matter both inside and outside my cranium; still, I once more realize my Hidalgo experiments are worth following up.

Primary dry crushing will further appeal to the millman when water is scarce. It also obviated much of the paraphernalia now in use.

H. W. HARDINGE

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Calculating the Niter in a Sulphide Ore Assay

The Editor:

THERE are two mistakes in my article, "Calculating the Niter in a Sulphide Ore Assay," as printed in the March issue, page 40. Instead of the equations being written as in the article, they should be written as follows:

R. P. = reducing power of sulphide mineral or group,
S = per cent sulphide mineral in sample,
W = weight of pulp sample in grams,
L = weight of lead button desired in grams, and
O. P. = oxidizing power of niter.

Grams niter necessary=

$$\frac{(R.P. \times \frac{S}{100} \times W) - L}{O.P.}$$

As an example: for Group II minerals with (R. P.) 7.6, (S) 100 per cent sulphide mineral content, (W) 0.5 A. T. (14.58) of ore, (L) 25-gram lead button, and (O. P.) as 4.2 for the oxidizing power of niter, the calculation of the upper end point becomes:

Grams niter necessary=

$$\frac{(7.6 \times \frac{100}{100} \times 14.58) - 25}{4.2} = 20.4 \text{ gm.}$$

LESLIE L. MOTZ.

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Re Assessment Work

The Editor:

I WISH to compliment you on the article by A. H. Hubbell on assessment work in the March issue. I am a prospector, now trying to develop three gold claims in San Diego County, California. I have seen the results of suspension of assessment work and, in my opinion, they are all bad. Suspension has caused women and "city prospectors" to locate claims they don't intend to develop. They don't know the mining law and don't want to learn. Their location notices are so vague it is usually impossible to orient the claim and they do other things to add to your worries. By suspending assessment work Congress has created a burden that will haunt the prospector for years after work is resumed, in the form of disputes over boundaries and every other matter that is disputable.

J. A. FULLER

What Metal Statistics Show

REACTION from rapid political developments in Europe late in March and early April shook the confidence of domestic metal producers and disrupted their outlook following earlier signs of business improvement. The tension has influenced industry in general, and some fear the resultant cautiousness of producers and consumers may intensify unless the tense situation abroad is relieved soon.

During the first quarter producers of copper, lead, and zinc sought to adjust output to consumption, and with the customary seasonal improvement now under way, statistics for the period are believed to have been kept in reasonable balance. The index of non-ferrous metal prices for the first quarter has hovered around 77, as shown on this page, against 74 for the same period last year.

Though the price of copper was unexpectedly lowered by a custom smelter on April 3 to 10⅜c., Valley, consumers did not rush in to buy metal. Large mine operators, however, maintained the 11¼c. quotation, believing little was to be gained by reducing the price at this time, owing to the extremely unsettled conditions prevailing here and abroad over the latest war scare.

Fabricators shipped products during February that contained 53,500 tons of copper. This was viewed as a good showing and compares with 59,900 tons in January and 55,000 tons in December.

Stocks of refined copper increased 7,848 tons here in February, but producers believe the statistical position of the metal will show steady improvement.

The Copper Institute's figures for January and February, in short tons, follow:

	Jan.	Feb.
Production, crude:		
U. S. mine	55,283	49,915
U. S. scrap, etc.	13,729	10,589
Foreign mine	92,244	87,826
Foreign scrap, etc.	14,857	13,412
Totals	(a)176,113	161,742
Production, refined:		
U. S. duty-free	66,182	59,225
Foreign	107,298	103,428
Totals	173,480	162,653
Deliveries to customers, refined:		
U. S. domestic	51,059	48,067
U. S. exports (b)	3,768	3,310
Foreign	95,762	98,221
Totals	150,589	149,598
Stocks at end, refined:		
United States	301,110	308,958
Foreign	178,949	184,156
Totals	480,059	493,114

(a) Revised. (b) Duty-free copper.

Exports of refined copper from the United States (foreign, refined in bond, and domestic metal), by countries of destination, during December, January, and February, in short tons:

To:	Dec.	Jan.	Feb.
Belgium	644	1,105	62
Czechoslovakia	723	163	684
Denmark	426	449	56
France	3,911	2,929	2,317
Germany	6,050	2,460	2,357
Great Britain	893	449	1,798
Italy	2,517	2,728	1,987
Netherlands	224	300	605
Poland and Danzig.	1,037	849	399
Sweden	359	521	3,616
China and Hongkong	11		
Japan	19,844	9,516	5,878
Other countries	871	457	1,093
Totals	37,510	21,926	20,843

▶ LEAD—The refined-lead statistics for February showed stocks at the end of that month of 122,112 tons, an increase of 4,898 tons compared with January. Continued shipments of accumulated lead concentrates in the Tri-State district are believed to have accounted for the slightly higher production rate now believed current. The trade believes that statistics for March will show improvement over those for February.

The refined-lead statistics for January and February, in short tons, follow:

Production:	Jan.	Feb.
From domestic ore	38,299	36,391
Secondary and foreign	3,208	2,945
Totals	41,507	39,336
Domestic shipments	40,189	34,421
Stock at end	117,214	122,112

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922-3-4)

1929	110.33	1934	69.56
1930	82.87	1935	74.66
1931	60.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67

	1937	1938	1939
January	87.03	75.56	77.12
February	91.68	73.43	76.89
March	103.78	72.41	77.09
April	98.62	71.19	....
May	93.25	69.15	....
June	93.21	67.55	....
July	93.82	72.95	....
August	95.28	73.94	....
September	94.33	74.70	....
October	85.26	77.61	....
November	78.91	78.36	....
December	75.18	77.13	....

▶ ZINC—Consumption and production of zinc are holding to a steady level and stocks of all grades for March decreased 207 tons. More small mines are being closed down because of the unprofitable prices now prevailing.

The American Zinc Institute's revised figures for January and February and statistics for March, in short tons, all grades, follow:

	Jan.	Feb.	Mar.
Stock at beginning	126,769	128,407	128,192
Production	44,277	39,613	45,084
Production daily rate	1,428	1,415	1,454
Shipments	42 639	39,828	45,291
Unfilled orders	34,179	29,987	38,447
Stock at end	128,407	128,192	127,985

Figures covering operations of the Prime Western division, for the first three months of the year, follow:

	Jan.	Feb.	Mar.
Stock at beginning	49,002	51,875	54,214
Production	19,659	18,266	20,813
Shipments	16,786	15,927	18,505
Stock at end	51,875	54,214	56,522

World production of zinc by primary metallurgical works amounted to 154,729 short tons during January, which compares with 152,805 tons in December and 157,519 tons in January a year ago, according to the American Bureau of Metal Statistics. Production outside of the United States for January was 110,587 tons, against 107,927 tons in December and 108,832 tons in January last year.

Lead Production of the World

Production of refined lead for the world, in short tons, according to the American Bureau of Metal Statistics:

	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan.-Dec. 1938	Jan. 1939
United States (a)	24,994	27,968	35,958	30,988	381,849	38,299
Canada	16,925	17,621	15,618	15,892	203,093	15,714
Mexico	21,615	19,408	14,819	7,020	228,261	6,732
Austria & Yugoslavia	2,000	2,151	1,527	1,780	21,912	(e)1,800
France	4,009	5,300	5,077	4,246	48,055	4,461
Germany	15,799	15,933	15,984	17,637	194,093	17,335
Italy	3,748	4,409	3,968	4,607	47,741	4,180
Poland	1,130	1,235	1,389	1,433	14,398	1,764
Other Europe (b)	15,700	15,800	15,800	16,000	184,200	16,800
Australia (c)	22,917	21,287	19,719	23,544	250,524	24,550
Burma	7,476	7,476	7,476	7,476	89,712	7,112
Tunis	3,176	2,308	1,312	3,602	26,203	2,205
Elsewhere (d)	9,700	14,600	12,000	20,000	139,700	20,800
World's total	149,189	155,496	150,647	154,225	1,829,741	161,752
United States	24,994	27,968	35,958	30,988	381,849	38,299
Elsewhere	124,195	127,528	114,689	123,237	1,447,892	123,453

(a) Domestic only. (b) Belgium, Russia, Great Britain, and Czechoslovakia; partly estimated. (c) Includes Australian lead refined in Great Britain. (d) Partly estimated. Comprises Argentina, Peru, Japan, and what is probably the major part of Spanish production; also the product of foreign ore smelted in U.S.A., and in recent months, Mexican base bullion refined in U.S.A. (e) Estimated.

General view of North Fork débris dam near Auburn, Calif. After many years Placer County will again be active with hydraulic mining

CALIFORNIA

North Fork Debris Dam Completed

Hydraulic mining operations will now resume in noted areas after many years of idleness—Idaho Maryland Mines Corporation will sink Brunswick shaft to 2,350 ft. level.—Chrome-ore production will be increased near Placerville

▶ With the completion of the North Fork debris dam about 4½ miles northeast of Auburn, hydraulic mining in Placer County, practically dormant since the Sawyer decision in 1884, is rapidly being revived and many dormant placer areas are being prepared for production. Among the many properties behind the dam, the Paragon, at Forest Hill, and the Lost Camp mine, at Blue Canyon, are reported to be ready for operation. The new dam has a capacity of 25,000,000 cu.yd. (estimated filling period about 20 years), and, in addition to storing mining débris, will serve in the control of flood waters. Under the Englebright bill, approved recently in Congress, the Secretary of War is authorized to enter contracts as regards to sale of water and outlet facilities provided by this and other dams under construction, which promises to reduce materially the ultimate storage cost to be paid by the miners. Funds derived from the sale of water for irrigation and power purposes from the dams would be applied to the cost of the dams, thereby reducing the total to be paid by the mine operators. Dimensions of the North Fork dam are as follows: Height, 155 ft; length, 620 ft.; crown thickness at base, 22 ft.; crown thickness at crest, 6.8 ft.; and total volume, 29,500 cu.yd. I. E. Burks, construction engineer, War Department, supervised the construction of the dam.

▶ At the annual meeting A. J. Heller, president of California-Engels Mining Company, announced that the company expected shortly to abandon the property of the Indian Valley Railroad Company, in which it owns an 89 per cent interest, and the right-of-way, locomotives, and other equipment are to be sold. The enterprise is being operated as a private road. The company will sell some $30,000 worth of machinery and equipment installed at the mine and mill at Engelmine, Plumas County. Capitalization of the company has been increased from 1,000,000 to 4,000,000 shares, and the purchase of the Groom mine, near Wickenburg, Ariz., ratified. A large portion of mining equipment is being stored at Crescent Mills for future shipment to the Groom mine. All property not in use will be sold. The company at one time was one of the leading copper producers in California. Offices are maintained at 350 California St., San Francisco.

▶ Sinking of the main shaft an additional 120 ft. has recently been completed at the Crystal mine, at Shingle Springs, El Dorado County, and current development work is centered in cutting out a shaft pocket, to be followed by drifting into unexplored ground. About 110 tons of ore are treated at the 125-ton counter-current cyanide plant. Benoni Lockwood, Jr., superintendent, is in charge of operations, and 55 men are employed.

▶ Santa Fe Gold Mines, Inc., controlled by Eastern interests, is reported to have acquired the properties of the Arlington Mining Corporation in Black Hawk Canyon about 35 miles from Victorville, San Bernardino County. A 600-ton cyanide plant is now under construction, following an extensive road-building program. R. K. Voorhies is vice-president and resident manager, and Algernon Del Mar, a director, is consulting metallurgist. About 80 men are employed. The company maintains offices at 55 Liberty St., New York City, and at 234 East Colorado St., Pasadena, Calif. H. S. West is president.

▶ Gus Helbach and Fred Anderson, of Grass Valley, have taken an option on the Ancho-Erie group of claims in the Graniteville district, Nevada County, and a comprehensive development program will be started as soon as road conditions permit. Plans include driving an 1,800-ft. tunnel and erection of a mill if satisfactory values are encountered. Mr. Anderson will be in charge of operations.

▶ Idaho Maryland Mines Corporation, Grass Valley, Nevada County, is sinking the New Brunswick shaft an additional 800 ft. to the 2,350 level, according to a report from Grass Valley. The work is expected to be completed within a year and will be followed by extensive lateral work on that horizon. Executives of the company are E. L. Oliver, president; Errol MacBoyle, executive vice president; and Albert Crase, general manager.

▶ In the Rattlesnake Bar district, near Placerville, El Dorado County, where considerable chromite ore was mined during the World War, United States Chrome Mines, Inc., is increasing the capacity of its reduction plant by the installation of larger crushing, grinding, and concentrating equipment. A power line 5 miles long and a 6-in. pipe line to bring water from the American River have been completed recently. The company is headed by A. H. Wild, of San Francisco, and George Beers, superintendent, directs operations.

NEVADA

Bradshaw Syndicate Resumes Operations

Tailing treatment starts seasonally earlier this year — Construction of new cyanide plant at the Standard mines soon under way

▶ Operation was resumed a fortnight earlier than usual, after the customary winter shutdown, by the Bradshaw Syndicate, Inc., treating around 1,500 tons per day of tailing from the long-dismantled 1,000-ton cyanide mill of the Goldfield Consolidated Mines Company. Metal recovery, nearly all gold, has ranged from $1.60 per ton in early operations to 85¢. per ton more recently. Albert Silver, of Tonopah, is directing metallurgist and M. A. Tanner, mill superintendent.

▶ With its output almost wholly from leases, production of the White Caps Gold Mining Company at Manhattan, Nye County, in 1938 was 3,159 tons, with average value of $33.995, compared with 1,749 tons, sampling $39.92, in 1937. Gross income in 1938 was $27,540. Water level was lowered to 1,150 ft. and winzes were sunk on several shoots of profitable ore. A five-year lease was secured on the adjoining property of the Manhattan Consolidated Development Company, and metallurgical tests were continued in efforts to solve the problem of treating the refractory ore, containing orpiment and realgar. Homer L. Williams, of Tonopah, is manager and John Connolly, president.

▶ The tailing treatment plant of the

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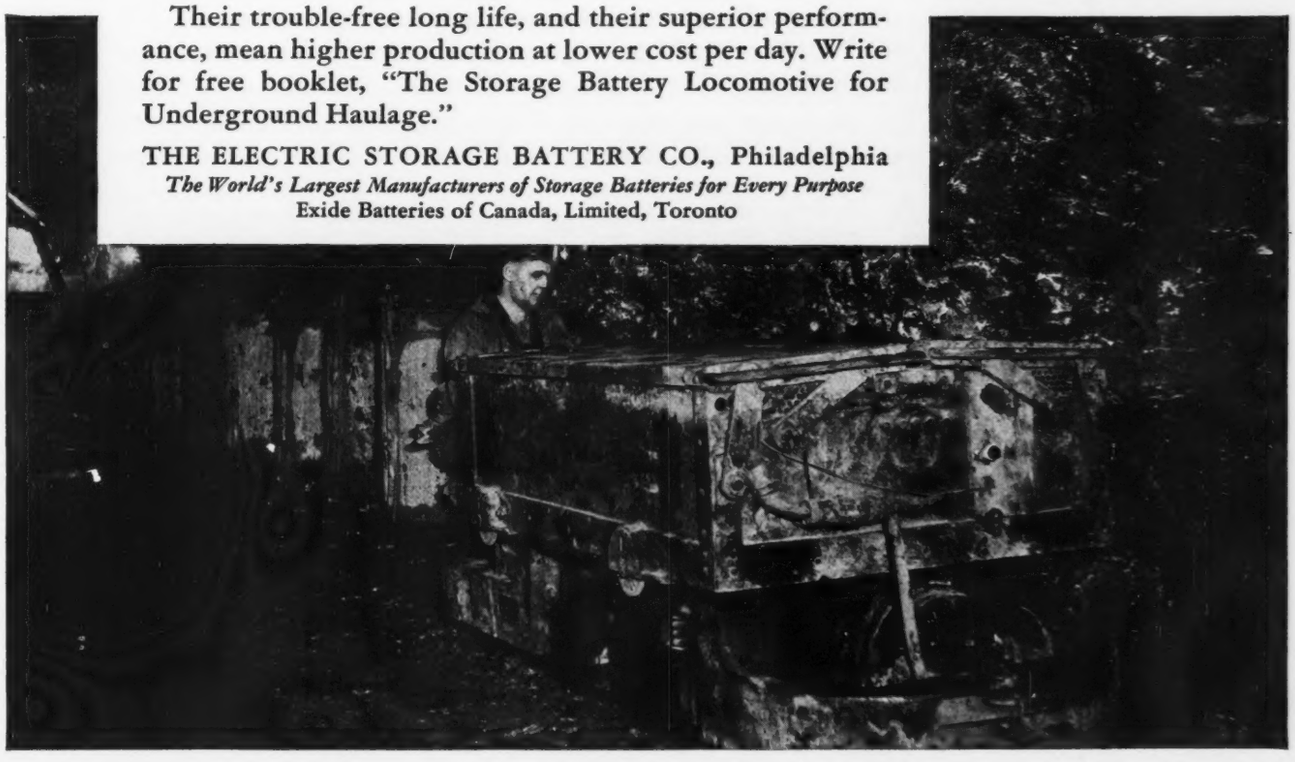

▶NEVADA

Dayton-Douglas Cyaniding Company, on the Carson River near Dayton, Lyon County, has resumed the treatment of tailing containing gold and silver from early-day mills on the Comstock lode. During the past few years the plant has made a notable recovery of gold and silver. Jay A. Carpenter, faculty member of the Mackay School of Mines of the University of Nevada, is head of the enterprise.

▶ Dividend No. 4, at the rate of 3¢. per share, was paid on March 20 by the Getchell Mine, Inc., making a total of $240,000 distributed in eight months.

▶ Production in 1938 from leases on property of the Goldfield Consolidated Mines Company at Goldfield had a gross value of $55,177, from which the company received $26,515.40 in royalties. Other receipts from mill tailing and oil royalties amounted to $7,934.76. Late in the year, failing to find additional ore, the Eastern Exploration Company, subsidiary of Calumet & Hecla Consolidated Copper, relinquished its lease and option on the properties. A further geologic study of the area is being continued. California Fuel & Utilities, Inc., paid $50,000 on notes held by the company. The Callahan Zinc-Lead Company made further advances of funds to the Livengood Placers, Inc., in Alaska, of which Goldfield Cons. owns 17 per cent. Prospecting was conducted on large placer-gravel deposits in Placer and Nevada counties, Calif. Scheelite deposits in southern Nye County, Nev., were prospected under option agreement. Other options were taken on mine concessions on the west coast of Columbia, S.A., but these were dropped in December. The balance sheet shows current assets of $311,084.29; investments and notes, $416,272.90. Net loss for the year was $56,049.35.

▶ Power connection has been made by operators of property of the Rio Grande Copper Company at Mountain City, Elko County, with the main line extending from Twin Falls, Idaho, by way of Jarbidge to the Rio Tinto mine of the Mountain City Copper Company. The Rio Grande shaft has been sunk 500 ft. and crosscutting is in progress to reach the ore zone. Three shifts are working under the direction of B. K. Zerbe, formerly superintendent of the Sunshine Mine in Idaho.

▶ An option to purchase the Ashdown mine, an early-day gold producer in extreme northern Humboldt County, was acquired lately by James Curley, former Governor of Massachusetts, for a reputed price of $150,000. A 10-ton concentrating mill has been in use by a former lessee and added equipment is being provided.

▶ Shipments of smelting ore have been made recently from the Mountain-View gold-silver property 18 miles northwest of Gerlach, in northern Washoe County, by the Burm-Ball Mining Company, working under a 90-day option agreement. President John Burmeister said that results of development had been highly satisfactory and indicated that if the option is exercised a mill of substantial capacity will be provided. S. A. Baldwin is in charge for the company, which has its main office at Auburn, Calif.

▶ Production of bullion from the cyanide mill at the Mill Canyon gold property, in Eureka County, operated under lease by Greenan & Company, Inc., in February was $23,192.22 from a total of 897 tons of ore, a net recovery of approximately $25.90 per ton. J. O. Greenan, First National Bank Building, Reno, is president and manager and N. H. Burley is superintendent.

▶ Construction of a 600-ton cyanide mill will begin in April at the Standard mine near Humboldt House, Pershing County, developed by the Pacific Syndicate and transferred to the newly organized Standard Cyaniding Company. J. B. Stott was in charge, and the company is headed by H. L. Hazen, president-manager of the Caliente Cyaniding Company. It is reported that mill ore so far developed totals around 1,000,000 tons.

▶ A 25-ton pilot mill operated by the Centennial Gold Mining Company in the Aura district, 12 miles from Mountain City, will be replaced shortly by a 100-ton plant, according to Alonzo Mackay, president, in a statement from the company office at Park City, Utah. The property, known as the Bull Run mine, was an early-day producer.

ARIZONA

Production From Small Mines Increasing

Several new low-capacity plants in prospect during year—Sheldon Mines, Inc., plans shaft sinking—New mill in Ark Basin starts production

▶ The Squaw Peak Mining Company, near Camp Verde, is sampling and testing a copper-molybdenum and gold ore deposit. Plans are made for the installation of a 25-ton test plant. Edison Thacker, of Camp Verde, is president of the company.

▶ Cherry King mine, near Cherry, is shipping an average of a carload of ore per month. The property is being worked by E. V. Bunker, W. H. Follett, and Jim Ragland under lease from Arden Van Dyke, the owner of the property.

▶ A carload of gold ore is being shipped monthly from the Gold Eagle mine, near Cherry. The mine is opened by a 160-ft. working shaft and 2,000 ft. of workings. The vein is from 6 in. to 4 ft. wide. This property is owned by the Golden Eagle Mining Company, R. M. Wombecker, president, and is being worked under lease to F. L. Bushe, Roy Belknap, and R. O. and C. A. Wombecker.

▶ An air compressor has been installed at the Gold Belt, mine near Morenci, and drifting is under way. It is expected that three cars per month will be shipped after the installation of further equipment. The property is owned by James Horton, of Sycamore Landing, Tenn., and is under lease to G. I. Pace and M. E. Moschetti.

▶ Arizona Drift Mining Company is installing underground machinery to care for the movement of pay material from the Dry Wash Wilson shaft, located in the La Cholla placer district. Eighteen men are employed. H. J. Waters is general manager, Box 7, Quartzsite, Ariz.

▶ The Ark and San Antonio mines, north of Kingman and near Mineral Park, have a 50-ton flotation mill ready for operation. The property is owned by the Greenmayer brothers. They claim to have a considerable tonnage available.

▶ A 25-ton test plant is being installed at the Horse Shoe mine, near Cerbat. The mill will treat ores from the Monitor mines and dumps. The property has been recently taken over by the California Spray Chemical Corporation, of Richmond, Calif., which is building the plant. O. F. Marvin, metallurgist, is at the plant working out the flowsheet. C. J. Artero is in charge of the work at the mine. The Monitor property, owned by J. H. Kane, was originally taken over by H. D. Ramsey and David Lawrence, who turned their options over to the chemical company.

▶ The Currens Mining Company operating in the Big Bug district near Prescott, is employing six men on its placer properties. A Bucyrus power shovel and three Linco bowls are being used. H. O. Welch, of Mayer, Ariz., is engineer in charge. R. S. Currens is president of the company.

▶ The Iron King Mining Company, at Humboldt, is treating 300 tons of gold and silver ore daily in its flotation plant and working a crew of 65 men in mine and mill. Gordon Tisdale is mill superintendent.

▶ The Blue Eagle claims, situated about 5 miles south of Salome, are shipping a third car of gold and silver ore. George W. Campbell, of Salome, is operating the property.

▶ Sheldon mine, at Walker, is shipping about three carloads of ore weekly. The shaft has been unwatered to the 300 level and it is planned to continue to the 500. The mine is operated by the Sheldon Mines, Inc., recently organized by F. A. Hartwell, G. D. Jermain, and M. E. Rogers. Old tailings at the Sheldon are being treated by the Grand Canyon Mining & Milling Company, Inc., recently formed by George Mainhart and Thomas B. Rice, of Kingman, and George D. Neville, of Douglas, which is handling about 250 tons daily.

▶ Seventy-five tons of ore from the Joker mine are going daily to the mill of the American Smelting & Refining Company at the Octave mine. The company is unwatering the old No. 3 shaft where ore was left by early operators. The Octave is under lease to the Arizona Eastern Gold Mines Company, M. E. Platt, superintendent, and T. A. Sneddon, mine foreman.

▶ Officials of the Golden Key Mining Company are planning the installation of a 50-ton mill. The Golden Key is an extension of the Congress orebody, and a shaft has been sunk to 240 ft. P. J. Morgan, Route 10, Box 205, Phoenix, is managing the operations.

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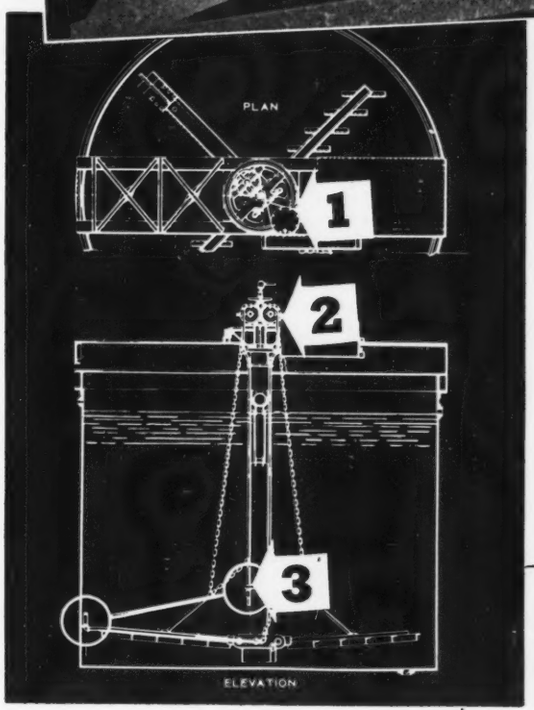

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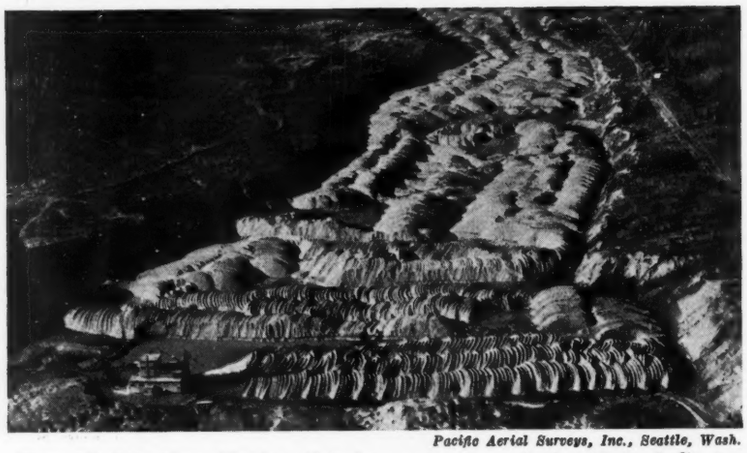

Pacific Aerial Surveys, Inc., Seattle, Wash.

Near Fairbanks, Alaska, this large dredge of the United States Smelting, Refining & Mining Company prepares for another year's operation in Cripple Creek

IDAHO

High-Grade Ore Found at Silver Dollar Mine

Shaft sinking to 1,000-ft. level is encouraged by recent developments — Aurora Mining Company plans to resume operations—Broader exploration program scheduled at Anchor mine

▶ Silver Dollar mine, in the Coeur d'Alene district, is drifting on the 625-ft. level in ore, following a rich strike of silver ore. High grade is being sacked and stored for shipment. The high-grade streak has widened from 1 ft. to 2 ft. in 15 ft. of drifting, President C. O. Dunlop, Spokane, stated. The main shaft will be continued to the 1,000-ft. level. A station will be cut at the 850-ft. horizon.

▶ Aurora Mining Company in the Murray district will resume operations this spring, according to announcement of H. H. Underhill, of Spokane, president.

▶ The mill at the Jack Waite mine, in the Murray district, was closed at intervals during March owing to danger from snowslides. Snow was 125 in. deep at the mine on March 15. The property was the scene of a disastrous slide several years ago.

▶ Plans for further exploration work at the Anchor mine, in the Murray district, are being completed, according to John George, of Kellogg, manager. Several shipments of high grade lead-silver ore were made last fall. Plans call for the erection of a 100-ton mill with other units to be added as underground operations advance.

▶ The mill at the Page mine of the Federal Mining & Smelting Company, near Kellogg, has been enlarged from 300 to 500 tons' daily capacity, according to F. H. Brownell, president of the company. Net income for the year, after deducting Federal taxes, amounted to $549,994.96. For the previous year the net was $1,734,098. The decrease in earnings was due principally to lower metal prices.

▶ Stockholders of the Jack Waite Mining Company, operating in the Murray district, are considering purchase of the Silver Falls mine, near Juneau, Alaska, for a reported price of $140,000. At the Jack Waite, 1,165 ft. of drifts were made in the past year on the Idaho side and 975 on the Montana side. American Smelting & Refining Company made a net operating profit of $22,677.05 at the property, which it holds on a long-time lease.

▶ Work is being resumed at the Crystal Spring Mining Company, near Lane, according to Luther G. Evans of Cataldo, president. Snow conditions caused a shutdown during the winter. A 500-ft. shaft is planned.

▶ Silver Summit Mining Company stockholders reelected Harry P. Pearson, Wallace, as president; William Yeaman, Yakima, vice-president; Martin Nocholson, Wallace, secretary-treasurer; H. J. Hull and L. E. Hanley, Wallace, directors. The shaft has reached the 700-ft. level on its way to the 1,000-ft. mark.

▶ Dayrock Mining Company, operating near Wallace, reelected F. M. Rothrock, Spokane, president; Henry L. Day, Wallace, vice-president and manager; John H. Wourms, Wallace, assistant secretary-treasurer; S. F. Heitfeld, Wallace, secretary-treasurer; F. W. Rothrock, Spokane, and Jerome J. Day, Wallace, directors. The company showed a net profit of $5,486.94 during 1938.

▶ Directors of the North Star Mining Company, operating in the Nine Mile district, have levied an assessment of one mill per share to carry forward development work and purchase a compressor for power purposes, according to G. W. Dougherty, Wallace, president.

▶ Operations are under way at the Coeur d'Alene Mines, in the silver belt, to prove the extent of the recently disclosed oreshoots on the 2,000-ft. level.

MONTANA

Larger Mill Planned at Butte Highlands Mine

Capacity to be increased from 50 to 200 tons daily—Operations resumed at the Two Percent Mine, at Philipsburg—Heavy snowfall this winter assures water for power supply

▶ It has been announced that the Butte Highlands Mining Company has passed its dividend, now due, to permit profits to accumulate against the enlargement of the present cyanide plant from 50 tons a day to 150 or 200 tons' daily capacity. Recent tests which are still in progress indicate that about 90 per cent of the gold in the newly disclosed sulphide ores in the east end of the mine may be recovered by cyanidation, and if this is possible, it will not be necessary to construct a flotation plant for the base ores. Accommodations of the mine have been improved and will now provide for about 100 men, whereas only about 50 are now employed. Earnings for January and February grossed $58,196.47, from which $24,652.40 is credit as net profit. The winze is 40 ft. below the 800 level and it is estimated that the ore zone will be cut about the middle of April. A new level will be made at 875 ft. W. L. Bell is manager.

▶ It is reported that progress at the Mammoth mine of Liberty Montana Mines Company, Jefferson Island, Madison County, has been satisfactory during the first quarter of this year. The mill has operated continuously at about 125 tons a day, and it is understood that a plan to install an electric haulage system underground will be started soon. The adits are up to 4,000 ft. in length and much of the production is derived from points most distant from the portals. W. D. Corrigan, Sr., is president.

▶ S. R. Knapp and A. V. Taylor have resumed operations at the Two Percent mine, at Philipsburg, after several months' inactivity at the property. Unwatering of the lower levels was started early in March after new pumping facilities had been installed. The Two Percent mine is a zinc-silver property, and the production is shipped directly to the Washoe Reduction Works.

▶ The Flathead mine of the Anaconda Copper Mining Company, near Kalispell, has maintained its usual rate of silver production throughout the winter, and in addition has been shipping high-grade lead ores to the East Helena plant of the American Smelting & Refining Company. According to reports, much new lead carbonate ore has been disclosed by development work done during the winter. Emmet Hale is superintendent at the mine.

▶ According to Forest Service reports, the snowfall in the high areas of the State has been above average this winter. This indicates that reservoirs will be well filled against power demands during the summer months.

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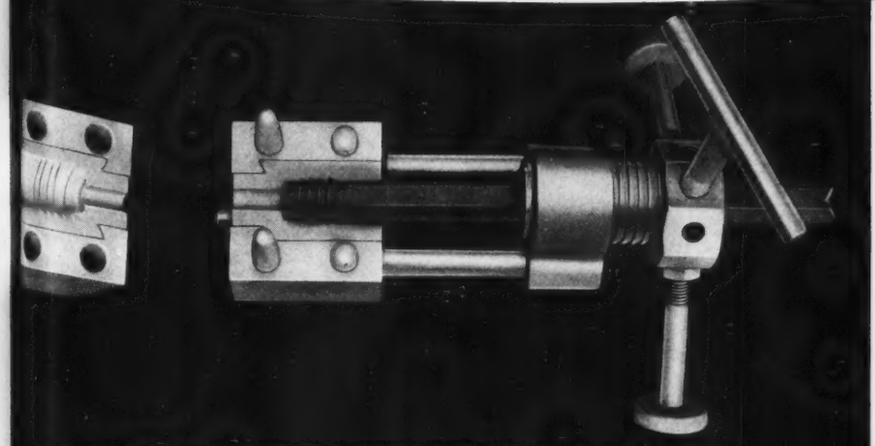

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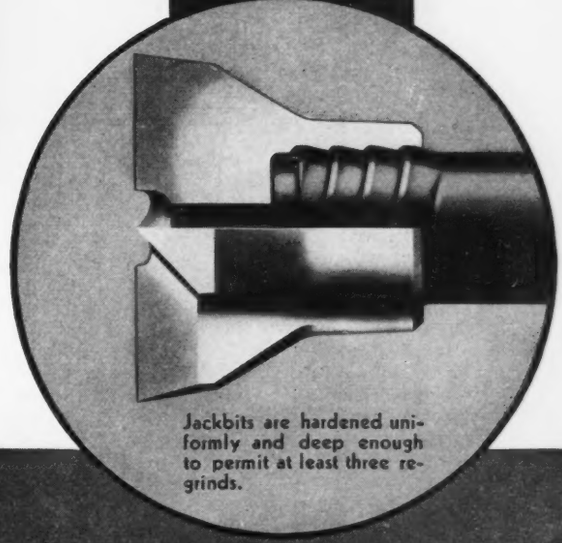
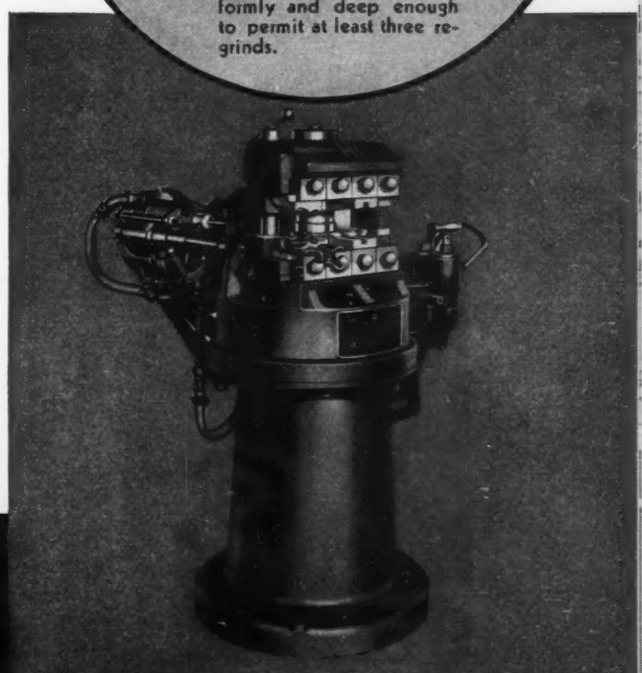


Jackbits are hardened uniformly and deep enough to permit at least three regrinds.



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NEWS FROM Washington

By Special Correspondent

FOREIGN PROBLEMS inevitably dominate all Washington thinking. There are as many speculative forecasts about each one of the important subjects as there are forecasters willing to express an opinion. These forecasts are important to the mining and mineral enterprises of the United States only as they suggest possibilities. Even those in highest positions have little more to go on than does the intelligent reader of the better daily papers.

Congressional activity is being devoted to many subjects, but the principal progress is on appropriations. It is evident that the leaders in Congress are inclined to go along with the President regarding a short session this year. The appeasement program obviously prevents any new reform measures. Some revisions of present law would be undertaken willingly if the leaders did not fear to open up important subjects. Minor changes so attempted are too likely to grow into major political battles, with embarrassment to the Administration if not actual loss of reform gains previously achieved.

What turn the legislation bearing on international matters may take is altogether unknown in the latter part of March. Expediency will determine this as European and Oriental affairs develop. Even the matter of preparedness by building strategic mineral stockpiles is involved in fundamental controversy that makes the result quite doubtful at this middle-of-the-session stage.

Tax Changes

CONSERVATIVES, with respect to business tax policy, have run away with the Hopkins idea of improved business relations by tax reform. The Administration does not like this. Certainly Harry Hopkins, who started the movement, had no intention of letting it run away as it has. The story generally believed around Washington goes about like this:

Hopkins wrote a speech for delivery in Des Moines. He sent it to the White House just before the President left for naval maneuvers and fishing. The President liked the idea of assuring business against further tax increases. He made a brief announcement to reporters before going to sea. Morgenthau grabbed the ball on what he thought was an official pass to him. He assured the public that the Treasury would cooperate. Then Senator Harrison and Representative Doughton, in command of appropriation committees in the two Houses, took charge. They announced that they would cooperate in modifying the tax law so as to stimulate business. Hopkins' speech was warmed-over mashed potatoes by the time he got to deliver it, very unpalatable to the Secretary of Commerce.

During the latter part of March all parties are trying to figure out what would do business the most good, with the least damage to the Treasury. One suggestion is a single corporation tax superseding all of the varied levies now imposed. Senator Harrison says that this would not increase the money cost to small business, and would not exceed 22 per cent of the profits of the largest enterprise. Other people advocate lower tax rates on the theory that they would raise as much money as now by stimulating business. Others talk merely about changes in details, for example modifying all capital gains and losses levies. Some Administration decision is likely to be reached perhaps before this issue of *E.&M.J.* reaches its readers.

Strategic Stockpiles

IN NORMAL TIMES the hearings before the Military Affairs Committee of the House and the report of the Thomas bill in the Senate would have attracted much attention. But Mr. Hitler's activities and the other pressing problems of daily concern to all people have so overshadowed these fundamental mineral questions as to cause almost complete neglect. Even the major newspapers, reporting the proceedings of Washington diligently, have largely ignored outstanding events.

The Senate Committee on Military Affairs has reported with the recommendation for passage the bill which would provide for acquiring stocks of strategic and critical materials. This measure as recommended to the Senate makes two significant changes from the original proposal of the interdepartmental committee, as previously reported in these columns of *E.&M.J.* The project has been enlarged from the idea of a mineral stockpile to be a materials reserve, including such commodities as coconut shells, manila fiber, rubber, and quinine, as well as the mineral requirements for preparedness. That proposal has not met any objection among the mineral group except on the ground that a limited sum of money so much more widely distributed may not give adequate reserves. They would be quite willing to have this enlargement of the program if the funds also were increased.

The second Senate change of greatest importance relates to the question of money expenditure this year and next. Originally the mineral economists recommended that $25,000,000 be spent each year for four years. So large a sum as this did not please the President at a time when he was having economy difficulties. In fact, the President, though stating approval of the idea of strategic reserves and favoring legislation, has outspokenly criticized the plan for actual appropriation this year in excess of $10,000,000.

The Senate bill provides that funds deemed by the President to be needed for this purpose may be appropriated from time to time. This puts on the White House the responsibility of annual redetermination of the rate of accumulation of reserves. Although not seriously questioning the judgment of the President or his support for the broad idea, the proponents of the original bill do express their dislike of any plan which makes preparedness moneys dependent on annual expediency decisions which may become political in nature. It seems, however, that the Senate is likely to adopt the bill with this money limitation.

Politics and Minerals

THE HEARINGS before the House Military Affairs Committee on the strategic minerals project have caused this measure to become deeply enmeshed in two kinds of political difficulty. One controversy is between those who favor low cost regardless of source and those who want to support domestic production for preparedness in order to enlist votes back home among those who have mineral properties. The second difficulty, which is mentioned only in whispers about Washington, relates to the alleged personal interest of members of Congress in mining properties which could be exploited if the stockpile bill included certain provisions for buying from domestic sources.

Many recall the scandals which were involved in the War Minerals Relief Commission cases. Perhaps the major purpose and application of Commission work rewarded only those who had rendered a bona fide service in good faith, but there remain clear memories of many other attempts of mineral groups to get their hand into Uncle Sam's purse. It is openly charged about Washington that stockpile building with any provision to favor domestic producers will merely reestablish a situation of that same character. The career officials in both civilian and military Departments are sincerely trying to avoid such a contingency.

Employment Rules

THE WAGE-HOUR DIVISION has made substantial progress in clarifying employment regulations for various divisions of industry. In one specific interpretation for the mining industry it has provided a clean-cut distinction between those things which are required and those things which are matters of Administrative judgment. A separate item presents these problems as they relate particularly to the isolated mining communities.

In general the observance of wage-hour regulations has been so conspicuous as to make the few cases taken to court a negligible fraction of 1 per cent of the total industry. Even more happy relationships are to be expected if a few modifications of the law are made in line with plans which Administrator Andrews has accepted as logical. The most important general exception for industry is likely to be the waiver of hours per week limitations for all classes of workers paid $3,000 or more per year. Some have urged that this exemption apply to those getting $2,400 or more per year. But that low limit is not likely to be accepted unless some

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The most serious question involved in these discussions is whether Congress will this year get around to making *any* amendments to the law of this sort. Such benefits can be expected only if the appeasement program is aggressively developed with active Presidential support.

New Magnesium Research

CONGRESS would like to have the Bureau of Mines develop new electrometallurgical methods for manufacture of metallic magnesium from the Washington State magnesites. This is in part also an effort to utilize the cheap hydro-electric power of the Columbia River dams at Grand Coulee and Bonneville. The major addition recommended by the House Committee on Appropriations for the money to be used by the Bureau of Mines next year relates to this subject. The sum of $35,000 will be provided if the bill passes as recommended to the House.

In other respects the House Appropriations Committee just about reaffirms last year's appropriations for the Bureau and for the mining and mineral work of the United States Geological Survey. Some of the requested increases in safety work of the Bureau and some new coal studies, both technical and economic, were denied. The major change in the Survey moneys is recommended with reference to stream gaging, for which substantial additional appropriation is suggested.

NLRB Reproved

BY THREE important policy-making decisions the Supreme Court reversed the previous action of National Labor Relations Board and reestablished many of the rights of industrial management which had theretofore seemed to be greatly restricted by Board action. Those who were previously keeping score, and stating that NLRB had won most of its cases, must now reverse their thinking because the following three Supreme Court decisions greatly limit Federal regulatory action.

1. Perhaps most fundamental was the 5-to-2 decision that sit-down strikes are a "high-handed" method, altogether illegal both in inception and in prosecution. The seizure and holding of employers' property by strikers using the sit-down method is unreservedly condemned as no more tolerable than would be any other form of violence or destruction of ownership rights.

2. A second decision said in effect that workers who strike in violation of an employment contract thereby sever their relations with the employer. Such action destroys the standing of the workers before NLRB, and makes any order for reinstatement or any requirement of further negotiation improper. The management need take no account of workers violating contracts any more than they need to deal further, except voluntarily, with those who indulge in a sit-down strike.

3. In still another decision the Court found that NLRB had not established by substantial evidence that a company was refusing to bargain with its workers. By implication this decision lays on the Board much more responsibility for *proving* wrongdoing on the part of a company management, not the mere taking of partisan workers' testimony and drawing of inferences without careful fact finding. Disciplining of companies for violation of the law, as by ordering them to reinstate workers or to do other required acts, must, it now appears, be limited to cases where really substantial evidence proves the company to have been legally at fault in the first place.

Stockpile Legislation

FOLLOWING its extensive hearings on eight proposed bills, the Military Affairs Committee of the House has reported in a slightly modified H. R. 5191, recommending passage. This bill, introduced by Mr. Faddis, closely parallels the Thomas bill in the Senate, which has also been favorably reported to the upper Chamber. In effect these bills provide for just those conditions of purchase of strategic materials as were originally proposed by the interdepartmental committee on this subject. (See *E.&M.J.* previous issue, numerous references.)

The next question, assuming enactment of this sort of bill, is the rate at which money will be actually appropriated for direct buying of goods. It is not likely that less than $10,000,000 will be granted this year, as the President has consented to that much. But it remains doubtful whether more enthusiastic supporters in Congress will be able to put over their recommendation that the whole sum of $100,000,000 be granted at once.

One of the important provisions in the legislation which is expected is a provision that the materials purchased shall be of a grade most satisfactory for military purposes. This is not stated directly but is understood to be included in the phrase "to determine the quality and quantities of such materials." Where domestic producers are able to meet quality requirements they will have the customary "Buy American" price advantage over importers. But if they cannot meet the desired quality specifications, as many cannot, their goods would not be accepted at any price. Certain manganese producers would probably get in, but many others would be outside the pale on this basis of interpretation.

Mining Securities

THE ISSUE of securities by mining enterprises involves very peculiar and technical matters when such new issues are before the Securities and Exchange Commission. For this reason American Mining Congress has been urging that a special mining registration division be set up by S.E.C. The committee suggestions to this affect have had formal approval in its declarations of policy of A.M.C.

To assist in the matter an informal Congressional committee has been set up which, it is hoped by those urging this plan, will aid in persuading S.E.C. to take action. The membership of this Congressional committee of cooperation is: Compton I. White, Idaho (chairman); James G. Scrugham, Nevada; Lawrence Lewis, Colorado; John R. Murdock, Arizona; Francis H. Case, South Dakota. The conferences during March encourage Secretary Conover to believe that some favorable consideration can be had for this plan.

News "Fines"

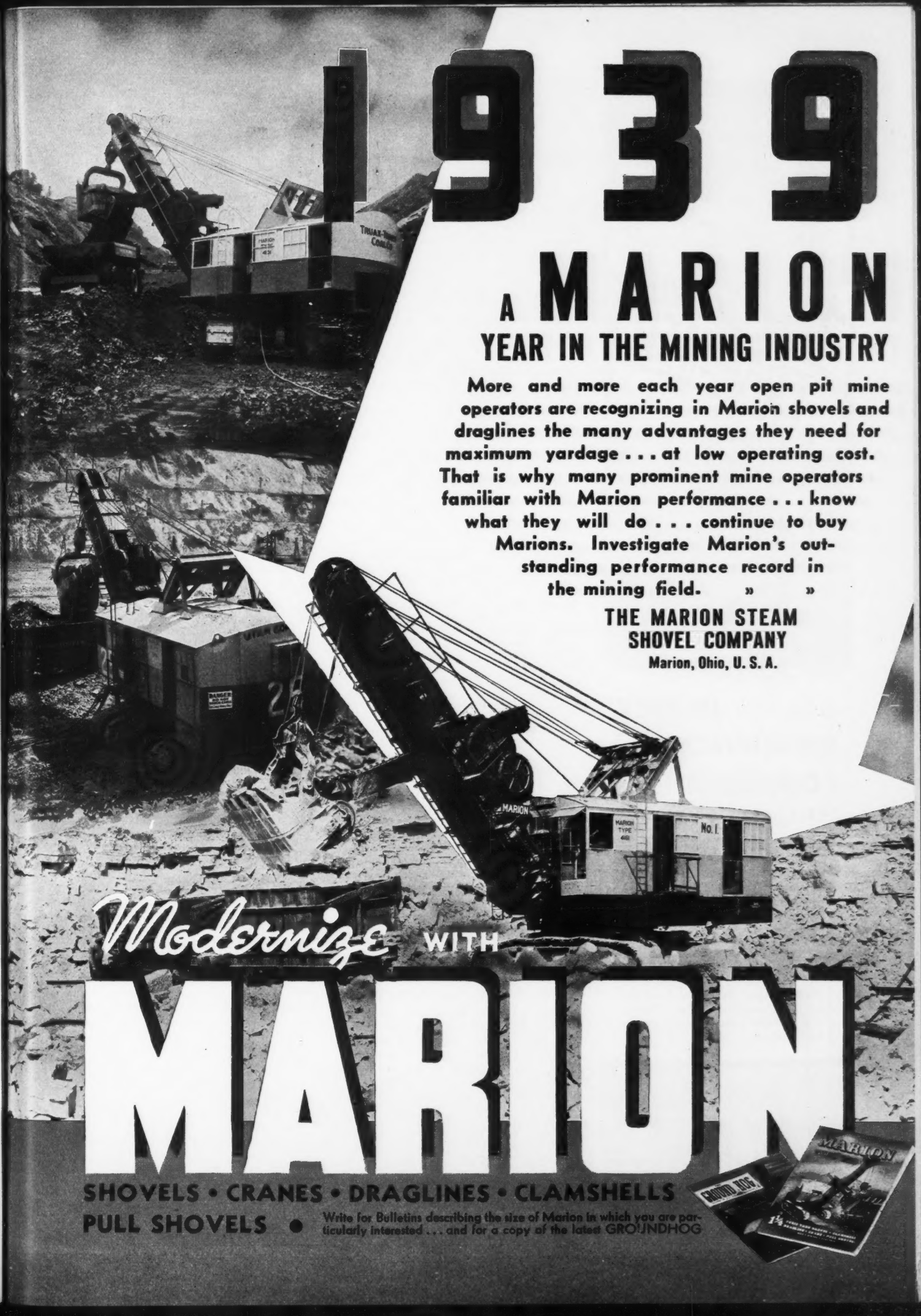
New Phosphate Furnace—The proposal that Tennessee Valley Authority have a new commercial-scale blast furnace with which to manufacture phosphoric acid by a novel process has stirred the whole question of public operation of a commercial enterprise in competition with industry. Decisions of the House and Senate differed on this $450,000 point, and the conference consideration became dominant. Final action is being determined, and may be announced before this issue of *E.&M.J.* is published.

Social Security—Plans for extension of social security to farm hands, household servants, and employees of nonprofit organizations like churches, fraternities, and trade associations were definitely voted out as a first step in Congressional review of this law. Other changes move slowly because of the general legislative situation, but some may be enacted before Congress adjourns.

Pollution Benefits — Reenactment of the stream-pollution control law, passed last year and vetoed by the President on a budget technicality, is still expected. Speaking on this matter before the Rivers and Harbors Committee of the House, Secretary Conover of American Mining Congress made a point that in some cases pollution from mines was claimed to be beneficial to maintenance of fish in streams. Neither this nor any other argument is likely much to change the law as enacted last year so far as technical features are concerned.

Money Legislation—There are even more political considerations involved in gold and silver legislation on which Congress is debating than there are with respect to strategic minerals. Until mid-March everyone supposed that the President would unquestionably get a continuance of his authority to modify the gold value of a dollar, as well as his authority to use the stabilization fund in international negotiations. But beginning about the Ides of March there were whispers that Congress intends to continue only the stabilization fund. But few, if any, forecast a discontinuance of some bonus on newly mined domestic silver.

Trade Agreements — The accumulated bitterness developed by Secretary Hull's trade agreement negotiations broke into the open during March, and some significant effort was made to restrict further negotiations and even perhaps to repeal some of the deals already made. Effective organization by State delegations is being undertaken among opponents. For example, the zinc-producing states are being drawn into line along with shingle producing areas and other agrieved states. Sugar cane and beet growers also are stirred up by proposed concessions in the Cuban agreement. The movement would bode ill for Mr. Hull if there were any likelihood of more negotiations of this sort, which is not likely with the world in the present chaotic condition.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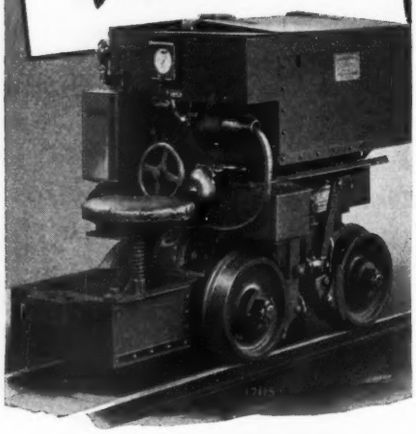

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COLORADO

Deep Ore Developed At Capital Prize Mine

Property located near Georgetown offers encouragement for deeper mining in nearby mines—Alma Syndicate Inc., plans to reopen mill to treat ore from Morning Star

▶ The large body of ore recently opened up in the Capital Prize mine at Georgetown, appears to be the important development of the winter in this mining area. The new pay streak is four feet wide and opened on a virgin wall of the Aetna vein, some 1600 feet below the surface. This has encouraged operators in the Atlantic group, such as Gold Dirt, Conqueror and other mines in this section and the Lamartine in Trail Creek. Joe Girard and the Coffman Brothers operate the Gold Dirt; while the Gold Bug, recently equipped with machinery, has several leasers working. The Aetna Vein has made a good showing from its north wall, and the crosscut which was driven seventy feet south last year caused some drifting and upraising that opened up a fine ore body, and which has been about definitely established as the south wall of the vein.

▶ The Directors of the Alma Syndicate Inc., are planning further development on ore bodies as well as resuming operations of the mill from the Morning Star surface deposit. By this development they hope to block out enough ore for continuous operations both winter and summer. N. P. Otis is general manager at Alma, Colorado.

▶ The Eagle county mines furnish most of the state output of silver and copper ore; of which a substantial tonnage is shipped by the Empire Zinc Company of Colorado. This company has extensive zinc ore bodies, but the six hundred ton mill built underground has been idle during the past several years due to low prices of zinc and lead. Exploitation has been confined to large bodies of copper-silver ore, and output shipped to the Garfield smelter in Utah. Mr. Jones is general superintendent, Frank Maloit mine superintendent, and Tom Garnett engineer in charge of safety and top supervision. Other producers of gold ore in this county, and which was mined from the Cambrian Quartzite formation of Battle mountain, include the Star of the West, Ben Butler, Alpine, Tip Top, Ground Hog, etc.

▶ Bad weather conditions have not stopped the progress of a new mill at the Bullion mine located on the crest of Collier mountain, Montezuma, Colorado, for treatment of lead-silver ore. Tables and stamps are to be installed in the mill, and later a jig will be put into operation. Other leasers in this vicinity are Jack Fletcher and Earl Sullivan on the St. Johns and Fred Hall and associates on the Juanita mine.

▶ The Treasure Mountain Gold Mining Company, at Silverton has purchased the Scotia and Chicago claims and the Eclipse placer on Treasure mountain. The company own some thirty claims in the San Juan area. A new plant was erected, and with the present equipment and some additions, both the Golden Fleece veins and the Scotia can be worked from the Santiago tunnel.

▶ E. A. Eliasen will develop the Sunbeam property at Crestone, Colorado, this spring; while Floyd Klostermyer and associates will work the Cleveland group of claims.

▶ Ted King and Leslie Myers are installing equipment on the Peg Leg Claim adjoining the Caledonia and Gold Bond on Gold Hill.

▶ The Cameron Company have been pushing development work along the north contact in the Cripple Creek District. The Champion Mines Company, the Jerry Johnson, Gold Bullion and the School Section have all been operating this territory. Wm. Kyner, editor of the Cripple Creek Times, heads the leasers of the School Section: E. A. Ritter, looking after the interests of the Champion Mines Company, has started sinking the shaft another hundred-odd feet deeper, in order that they might get to ore under the winze on the 425-foot level.

▶ During 1938, the Cresson mine spent some four hundred and thirty-odd thousand dollars for labor, materials, etc., and of this amount over thirty thousand dollars constituted taxes and social security. To offset this heavy expense, A. H. Bebee, manager of the Carlton interests in Cripple Creek, was successful in reducing mining costs over twenty cents per ton. The largest tonnage of ore is being taken from the 18th level, which is well below the Roosevelt drainage tunnel.

▶ The Savage mine in La Junta basin, Telluride, and which has been operated for years by the Blixt Brothers has been purchased by Hans Wulf of St. Louis, Mo.

▶ W. A. Moore has taken over the Smuggler tunnel below Ward, Colorado, and is now installing a compressor, etc.: the Betasso mill treating ore from the Lucky Two mine is again in operation.

Research Fellowships Open

▶ The School of Mines of the University of Alabama is offering fellowships in mining and metallurgical research in cooperation with the United States Bureau of Mines, open to qualified graduates of engineering schools. The value of each fellowship is $500 per year of nine months beginning Sept. 1. Holders must register as graduate students, candidates for degree of master of science unless an equivalent degree is held. Problems selected for investigation for the year 1938-39 are: Coal preparation studies, beneficiation of non-metallic minerals, beneficiation of iron ores. Fellows will be exempt from laboratory and non-resident fees, but will be subject to certain minor fees required of all students. Applications must be received not later than May 1, and should be addressed to J. R. Cudworth, Director, School of Mines, University of Alabama, University, Ala.

UTAH

More Funds Needed For Experimental Station

United States Senate Appropriations Committee requested to restore $100,000 cut for building Bureau of Mines station in Salt Lake City

▶Outlook for the building of a central experiment station of the United States Bureau of Mines at Salt Lake City on the University of Utah campus became black, when, after the opening of bids, it was decided that the federal appropriation of $300,000 was insufficient. Ryberg Brothers, Salt Lake City construction firm, submitted the low base bid of $245,000 for erecting the building. This figure, with existing commitments of $30,000 and $10,000 for landscaping, leaves practically nothing for equipment. Dr. R. S. Dean, chief engineer of the bureau, estimated that an additional $100,000 would be necessary to erect the building and equip it properly. Representative J. Will Robinson has asked the Senate Appropriations Committee to restore the $100,000 item deleted by the House. John W. Finch, director of the Bureau of Mines, is understood to favor the restoration of the item.

▶James Ivers, vice-president and general manager of the Silver King Coalition Mines Company, was elected governor of the Utah Chapter of the American Mining Congress at the annual meeting on March 22. Mr. Ivers, formerly first vice-governor, succeeds E. A. Hamilton, who was reelected as a director. Other officers elected: William J. O'Conner, manager of the American Smelting & Refining Company, first vice-governor; F. S. Mulock, vice-president and general manager of the western operations of the U. S. Smelting, Refining & Mining Company, second vice-governor; Floyd M. Wiles, manager of the Park City Consolidated Mines Company, third vice-governor; A. G. Mackenzie was reelected executive secretary.

▶The 1939 session of the Utah State Legislature made few, if any, changes affecting the status of metal mining producers. Occupational disease compensation, a state wages and hours, and tax laws, which might have vitally affected the industry, failed. The Legislature passed but Governor Henry H. Blood vetoed a bill creating a disabled miners' hospital for silicosis patients at Ogden, adjoining the new Utah State Tuberculosis Sanatorium, on the ground that the plan proposed had several objectionable features.

▶Fire insurance companies recently paid the University of Utah $35,000 for damages caused by fire at the old Mines Building, now being repaired.

▶Victor G. Pett, chairman of the labor committee in the House of Representatives, Utah State Legislature, was appointed assistant metal mines inspector by the industrial commission on March 15. Mr. Pett is a hard-rock miner of many years' experience in the Tintic district, Eureka, Utah.

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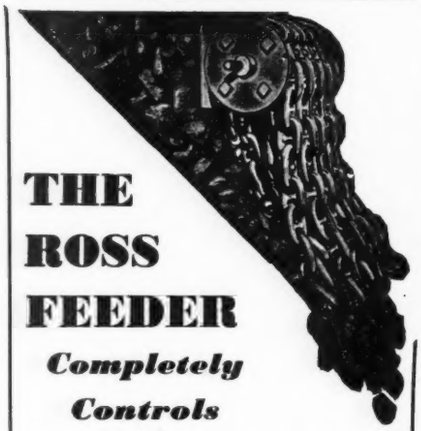

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New custom mill of the Eagle-Picher Mining & Smelting Company at Oronogo, Mo., will treat mixed sulphide and oxidized zinc- and lead-bearing ores mined from the Oronogo Circle and ore accumulated on nearby dumps.

TRI-STATE

Curve of Activity Declines Further In District

More mines shut down as low metal prices continue, and new zinc tariff lowers margin of profitable operation — Eagle-Picher Mining & Smelting Company pulls pumps from deepest shaft in district

▶ The low zinc concentrate prices are gradually resulting in the closing of more and more low grade mines and tailings retreatment mills in the Tri-State area. Many operators kept their properties going in the hope that prices would increase with the reported recovery that was to come with the spring. These better prices are not being realized and the hope for any future increase in prices is fast dwindling, as there are very few operators that now see any chance for a change for the better in the London market. The trend seems definitely toward reduced production and increased unemployment.

▶ The Beaver tailings retreatment mill of the Commerce Mining & Royalty Company closed the middle of February for an indefinite period. Approximately 30 men were affected by the shutdown.

▶ The Atlas Milling Company closed its tailings retreatment mill early in March with the loss of employment to 35 men according to R. O. Gibson, company superintendent.

▶ The Federal Mining & Smelting Company has closed its central mill at Spring City, Missouri. All underground equipment and pumps have been pulled out of the ground with the exception of a Pomona and Texas pump, which have been shutdown but not pulled. Between 30 and 40 men will be affected by the shutdown.

▶ The Eagle-Picher Mining & Smelting Company has pulled the three large turbine pumps from the Garrett deep shaft three miles north of Treece, Kansas. These pumps had a total capacity of 6,000 g.p.m. The 435-foot shaft was the deepest in the district and its development in an otherwise unproven area was watched with great interest by other operators of the district.

▶ The sale of the Kropp mines, mill and all appurtenances of the Indian Mining & Royalty Company to the Davis-Big Chief Mining Company was announced March 18, by Henry Hoffman, president of the former company. The sale was confirmed by Claud R. Jones, president of the Davis-Big Chief Company. The Kropp leases consist of 200 acres of non-restricted Indian land and are served by a mill with a capacity of 30 tons per hour. The Davis-Big Chief company is mining on the Netta lease of the Eagle-Picher Mining & Smelting Company and sending the ore to the Central mill of the latter company. The Davis-Big Chief company has mined on various leases of the Eagle-Picher company over a period of years but this is the first milling operation that the company has undertaken.

▶ The Admiralty No. 3 mine was reopened by the Eagle-Picher Mining & Smelting Company early in March with approximately 35 men re-employed. The ore is transported to the Central mill of the company for treatment.

▶ The Eagle-Picher Mining & Smelting Company has installed two of the new Henry crushers at its lead smelter in Galena, Kansas. This crusher is unique, in that the stationary jaw of the Blake type crusher has been replaced by a movable roll, the movement of which is synchronized to the movement of the movable jaw. The movement of the roll is adjustable either with or against the flow of the feed. The larger of the two crushers is being used to reduce galena concentrates for recleaning over jigs and with the roll moving against the flow of the feed produces a sized, granular product with practically no slimes. The smaller crusher is used in the research laboratory with some very interesting results being obtained.

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TAPES . RULES . PRECISION TOOLS

American Zinc Institute To Meet in St. Louis

▶ The American Zinc Institute will hold its annual meeting at the Hotel Statler, St. Louis, Mo., on April 17 and 18. The Institute's promotion work will be featured. Other topics to be presented are Washington news, the zinc market, and the zinc situation abroad.

MICHIGAN

Exploration at Seneca Mine Encouraging

Investigation so far made by Calumet and Hecla Consolidated Copper Company of Seneca mine from lower levels of Ahmeek indicates ore extension — Isle Royale produced 2,519,597 lbs copper in 1938

▶ Calumet & Hecla Consolidated is penetrating Seneca ground, on which it has an option, from the lower levels of Ahmeek No. 4 shaft. Because of irregularities in the distribution and trend of the ore shoots which make up the Kearsarge ore body, it will require several thousand feet of work in a number of levels before it is known whether or not ore shoots of a size, grade and frequency necessary for profitable mining exist in the Seneca, now known as the Peninsula area. The opening of several hundreds of feet of lode on the 33rd level however, has revealed a grade somewhat above the Kearsarge lode average, which gives encouragement to the exploration. The major interest in Seneca is because it includes a large area adjacent to the openings in the Kearsarge lode at North Ahmeek. Openings in Ahmeek indicate that copper mineralization in the lode extends to some degree at least into Seneca or Peninsula territory.

▶ Calumet & Hecla is doing a thorough job of exploration at the Michigan mine in Ontonagon county, a property it has under option. Surface diamond drilling has indicated mineralization attractive, crosscutting and drifting are in progress from an old adit opening into the western part of the Evergreen bluff. The drilling operations covered the Evergreen series and extended along the strike of the lodes for a distance of approximately two miles northeast of "E" shaft, about a mile of which produced encouraging results.

▶ Production at the Isle Royale mine, which resumed operations in July after a shut-down period of six years, totaled 2,519,597 pounds of refined copper in 1938. The average cost sold was 9.869 cents per pound, exclusive of charges which amount to 2.999 cents. Seventy-five per cent of the output was sold, at an average price of 10.532 cents per pound. The yield per ton was 23.809 pounds, which is about the average of the last 10 years the mine operated. A portion of the Isle Royale product contains silver in commercial quantities.

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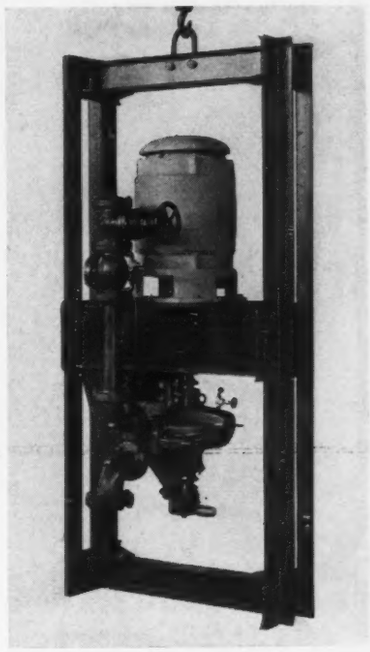

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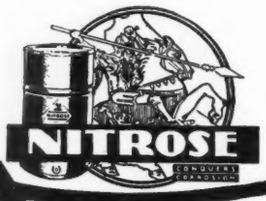

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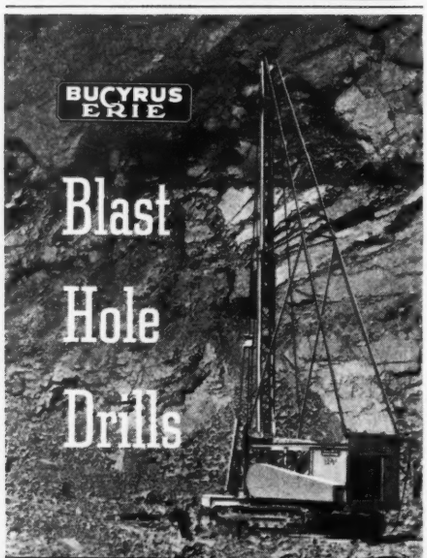

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▶MICHIGAN

A total of 8,308.51 ounces of silver was recovered in 1938, which netted $1,481.75 after charges. An additional 4,554.69 ounces were recovered, returns on which have not yet been received. It is proposed to step up copper rock production to 750,000 tons per month. Output has been at the rate of about 500,000 tons.

▶ Examination of Michigan copper and iron mines is being completed this month by the Geological survey division of the Department of Conservation. F. G. Pardee, mining engineer, and G. E. Eddy, mining geologist, are making the examinations and checking figures with mining company officials. The figures form the basis for recommended valuations given to the state tax commission each spring and must be available by May 1.

IRON COUNTRY

Production Schedules to Be Announced Soon

Operators look for a fair rate of iron ore output for the 1939 season—Consumption holding around 3,000,000 tons per month

▶ Consumption of iron ore during February by blast furnaces using Lake Superior iron ore amounted to 2,852,540 tons, compared with 2,926,706 tons in January. The balance on hand in furnace yards and Lake Erie Docks on March 1st was 28,840,053 tons.

▶ Practically all companies are waiting for schedules from the Eastern offices, and meetings will be held between the last week of March and the 10th of April when definite production schedules will be determined for 1939 operations. With consumption of iron ore running about 3,000,000 tons per month, there will be less than 23,000,000 tons on hand May 1st, and it is definitely expected that the consumption will increase during the remainder of the year. This should give the operators a fair season and take care of employment in a pretty fair manner.

▶ The United States Steel Corporation is planning on setting up 64 boats this season compared with 31 last year.

▶ The Charleson Mining Company, Hibbing, Minnesota, is installing new jigs in their plant at the Judd Mine located at Taconite, Minnesota.

▶ Butler Brothers are building an addition to the Harrison Plant located at Cooley, Minnesota.

▶ The Itascan Ore Company, Duluth, Minnesota, formed by the Congdon interests in Duluth, owners of the lease on the Canisteo Mine, have appointed the Cleveland-Cliffs Iron Company the operating agent.

▶ The various mining operators in the Iron Country are employing small crews repairing equipment and a few are stripping overburden.

CANADA

Cut in Quebec Mining Claims Tax Proposed

Changes in mining laws held to benefit future prospecting and exploration—Premier Duplessis of Quebec appeals for more British capital to be invested in developing Canadian mines

▶ "Capital invested in the mining industry will be safeguarded; it will be treated with justice, even generously," Premier Maurice Duplessis of Quebec stated in the course of a strong appeal for the investment of more British capital in the Canadian mining industry, as he spoke to members of the Canadian Institute of Mining and Metallurgy at the annual banquet held last month in Quebec City. Canada was cited as the land of opportunity and deserving of a larger share of the funds that had in the past been invested in Africa and South America. The Premier opposed state control, believing that real progress could only be based on honest private initiative. Duplication and even triplication of taxes by Federal and Provincial Governments was discussed as an evil that might be eliminated. Federal taxation of natural resources was considered unfair both to the provinces and to mining investors.

▶ The Quebec Bureau of Mines proposes to cut in half the annual rental or tax on mining claims, and to allow prospectors 5 per cent of the proceeds of treasury shares over and above the pooled stock held as a vendor interest when their property is taken over by a company. In Ontario, the Mining Act has been altered by the Provincial Legislature with the most sweeping changes to be introduced since 1930. Among the 164 changes are many that benefit prospectors; high-grading is to be combated by licensing all precious metal refineries; rules have been extended and revised for medical examination of miners in the campaign against silicosis.

▶ Pierre Beauchemin, vice-president of Sullivan Cons. Gold Mines, adjoining the Siscoe, reports satisfactory ore conditions intersected by crosscuts on the four bottom levels, from 850 to 1,150 ft. Monthly gold production is now in excess of $90,000.

▶ A million tons of $7 ore has been indicated on the Norgold and the adjoining Cassels Duval properties, located about 15 miles east of Noranda, where diamond drilling has been going forward steadily in the interests of U. S. Smelting, Refining and Mining Company. Apparently the dip carries the ore east into Norgold ground, where a length of 600 ft. shows an average gold content of about $8.50 a ton. Widths, so far, average about 20 ft.

Ontario

▶ Wendigo Gold Mines, in the Lake of the Woods district, is planning shaft deeping below the 800-ft. horizon to open two more levels and, if favorable ton-

nage increases result from deeper development, the mill capacity is to be increased to 150 tons daily. Ore reserves stand at about 60,000 tons, according to Horace G. Young, vice-president and general manager.

▶ Extraction of 94 per cent has been maintained by the efficient 360-ton mill designed by Dunn and Dowsett for Madsen Red Lake Gold Mines, which went into production last August. Gold recovery at $7.99 a ton is remarkable in that the official ore estimates had been based on values 25 per cent lower. Amalgamated concentrates taken off by jigs after grinding in water, supply more than a third of the gold recovered. Pyrrhotite in the ore makes it necessary to give the pulp pre-aeration in three Pachuca tanks. The pulp is then dewatered and passes through a cyanide circuit.

Manitoba

▶ Important new ore indications are being explored by drifting south on three levels to the area that was diamond drilled last fall on the property of Gurney Gold Mines. Gross production of $456,319 in 1938 is reported by the president, C. Gordon Smith, providing net profit of $19,101. C. B. Dawson is consulting engineer.

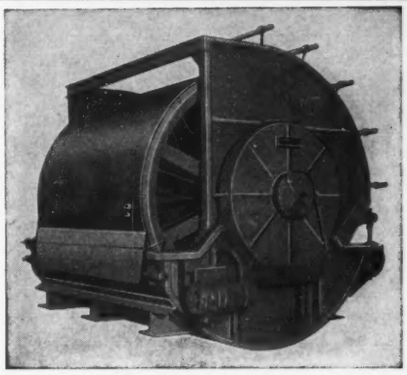
▶ A general program of development on existing levels is being carried out by Gunnar Gold Mines, located in the Central Manitoba area. Production last year was highly successful, showing an increase in value of $619,058.

Northwest Territories

▶ Good progress is being made by Thompson-Lundmark Gold Mines on its property located 30 miles east of the town of Yellowknife, north of Great Slave Lake. Since last July, when the first discovery was made, considerable mapping and surface work have been carried out, camps built to house 50 men, a winter road cut to Yellowknife and a mining plant installed. Following 7,000 ft. of drilling, a 140-ft. inclined shaft has been sunk on the Kim vein. After opening up the first level the shaft will be continued to 250 ft. Diamond drill holes have proved the Kim vein for a length of 1,750 ft. and to a vertical depth of 400 ft. Sampling surface exposures at the north end of the vein showed $30 ore 25.8 ft. wide for a length of 450 ft. Another 125-ft. vein section averaged $55.30 in gold per ton over 12.2 inches. Ken Muir is resident manager, and E. V. Neelands consulting engineer.

▶ Since last August the Con mine of Consolidated Mining & Smelting at Yellowknife has produced over $350,000 in gold. Mill capacity is now being increased from 100 to 175 tons daily, and arrangements have been made to treat ore from the adjoining property of Rycon Gold Mines, also controlled by Cons. Smelters.

▶ Negus Mines, adjoining the Con property on the south, started operating its 50-ton mill in February as the second gold producer in the Yellowknife camp. A. E. Kipps, consulting engineer, reports that mill heads have been averaging $46 a ton. Joseph Errington is vice-president.



CONTINUOUS - VACUUM

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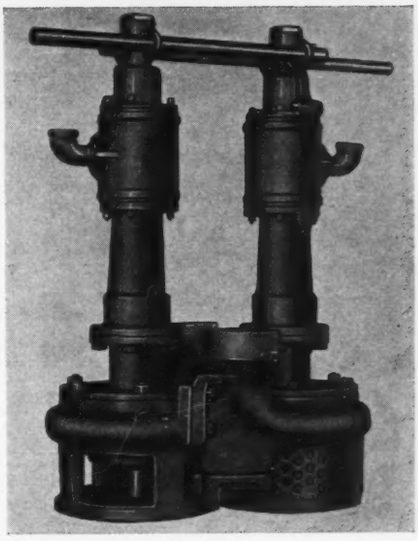

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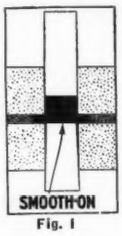

Fig. 1

Removing the nearest bolt and forcing Smooth-On No. 3 into the packing space is also excellent procedure. This may be done by closing one side temporarily with a wooden plug (Fig. 1) and forcing the Smooth-On into the other with a hammer and close-fitting rod. Where studs are used in the flanges, the stud may be reversed (Fig. 2) instead of using a plug, or the Smooth-On may be filled in through a temporary stud drilled through the center to take a smaller rod, and crosswise with holes leading into the packing space (Fig. 3). A grease gun may be employed to force in the Smooth-On by inserting a threaded pipe, drilled crosswise, capped on one end, locked on the other with a nut, and providing threads for attaching the gun (Fig. 4).

Fig. 2

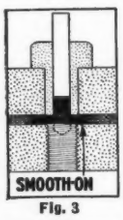

Fig. 3

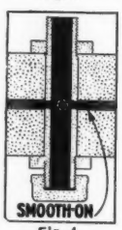

Fig. 4

Adjoining bolts may be treated successively. If the leakage is confined to a small area, drilling a small hole into the flange, forcing in the Smooth-On and closing the hole with a threaded plug may be a time saver.

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▶CANADA

British Columbia

▶The Zeballos gold camp on the west coats of Vancouver Island, where three properties are in regular production, two years after the first development of any magnitude was undertaken in the area, has now produced its first annual report. In a review of operations of Privateer Mine Ltd., the directors state that the total value of output from May, 1937, to February 28, 1939, was $838,714. Ore reserves are estimated at 45,389 tons of developed ore, averaging $32.90 per ton, and 22,318 tons of partially developed ore, averaging $26.60, the whole averaging $30.80 per ton. Joseph Pedneault of Victoria is president, G. F. MacDonnell is consulting engineer, and J. W. Murray is assistant manager.

▶Development of the Central Zeballos mine is now under the control of Reno Gold Mines Ltd., which has agreed to expend at least $30,000 on the property, and if justifiable, finance the construction of a mill. In return Reno will be paid 40 per cent of revenue before deducting depreciation and depletion. N. F. Brookes is the Reno engineer in charge.

▶J. E. Hammell, prominent Toronto mining operator, has agreed to finance the exploration and development of the Zeballos Gold Peak mine, subject to the approval of the deal by the shareholders. It is proposed that $50,000 be spent on the work in addition to whatever mining plant may be required, which it is believed would cost a further $20,000. F. L. Borup is the representative of Mr. Hammell in British Columbia.

▶Vancouver interests have invested $100,000 in Proserpine Gold Mines Ltd. to finance the first stage of an intensive test of the company's property, situated on the Barkerville gold belt 6 miles southeast of the Cariboo Gold Quartz mine. C. S. Cradock of Vancouver is president of the company.

▶Ore of a good grade has been encountered in the raise being driven at Cariboo Hudson from the 600-ft. to the 300-ft. level, according to Fred M. Wells, director in charge of operations.

▶Several properties in the Yanks Peak section of the Cariboo district are being tested this year. One of these, the King Midas, is under the control of the Amparo Mining Co. of Philadelphia, which for many years has been operating in Mexico.

▶Germansen Ventures Ltd., a subsidiary of Venture Exploration Co. (East Africa) Ltd., expects to commence production this season from the placer deposits it has had under development for several years on Germansen River, in the Omineca district, northern B. C. Frank de Ganahl, managing director, states that the company has spent more than $1,000,000 in the area.

▶The Consolidated Mining and Smelting Co. will resume shortly the exploration of the Salmon Gold mine, situated in the Portland Canal area 8 miles from the Big Missouri. Consolidated's option has been extended for three years.

▶A 60 per cent interest in Utica Mines Ltd. has been sold to the Armstead interests of Washington, D. C., for $50,000. This sum, it is believed, will be practically sufficient to bring the company's Slocan property into production on a small scale. The deposit, carrying values in silver, lead and zinc, is partially developed.

MEXICO

Strikes at Monterrey and Avalos Smelter Settled

Labor difficulties at other mines pacified —Management of Cia. Minera El Ano Nuevo S.A. turns properties to employees

▶Spring found mining in Mexico carrying on, but cautiously and rather anxiously in view of the republic's economic situation which continues none too good and, at present, has scant prospect of improvement. Production is holding up well; the 1938 output, for most of the line, promises to be higher than that of 1937, according to government estimates. Labor troubles continue though some such difficulties were patched up with the granting of most of the workers' demands. Mining cooperatism is spreading. The cooperative that has been running properties of Cia. Minera Dos Estrellas for a year made net profits of 600,000 pesos (about $120,000) after repaying a federal loan of 200,000 pesos (some $40,000), according to the federal labor department.

▶The four and one-half months strike at the refinery of the American Smelting & Refining Company in Monterrey was settled on March 23, when the company agreed to pay 95,000 pesos ($19,000) on a new wage scale and 60 per cent of salaries making the total outlay close to $22,000. Men returned to work one hour after the settlement. The company also averted trouble at it's San Pedro and Barreno units in San Luis Potosi by increasing wages 30 centavos per day.

▶A strike occurred when 1,800 employees walked out at the Avalos unit of the American Smelting & Refining company in Chihuahua because of nonsettlement of a labor dispute by March 22. The strike lasted only 39 hours. The Federal Labor Department intervened and induced strikers to accept the new labor contract and normal operations soon followed. Another strike was settled by the company by granting a daily wage increase to employees at the Angangueo unit in Michoacan. Wages were increased 25 to 40 centavos retroactive to January 13th.

▶Because high taxes and frequent demands for increased wages made operation unprofitable, Cia. Minera El Año Nuevo, S. A., James E. Harding, owner and president, gave its properties at El Arco, Lower California, to its employees under a provisional agreement approved by the federal labor department. The company also gave the work-

ers tools and other equipment to enable them to get started on a cooperative basis.

▶ Normalization of operations by Cia. Minera de El Boleo, S. A., is announced.

▶ A series of sit-down strikes is being waged by Guanajuato co-operative miners, including those who are running properties of Guanajuato Reduction, as a protest, they assert, against the state governments' failure to protect them from high graders and ore thieves.

▶ Work difficulties were smoothed over by Cia. Minera de Maguarichic, S. A., Maguarichic, Chihuahua, by signing a new labor contract that allows higher daily pay of 6.25 pesos ($1.25) for miners, 5.60 pesos for surface workers and an extra 85 centavos (17 cents) for employees receiving the minimum daily wage. Lives of all employees are insured for 500 pesos ($100) each; 1,000 days wages will be paid as compensation for accidental deaths; the company is to pay expenses of its employees' delegates to yearly labor conventions in Mexico City and create a savings fund for its workers.

▶ Operative difficulties were overcome by American Smelting at its Santa Eulalia unit, Chihuahua, by granting a labor contract that allows such privileges as more days in paid yearly vacations, larger free medical service and distribution of medicines, more free homes and baths, and 60 days wage and 10 days salary for each year of work, to those who are dismissed.

Chili Passes Copper Profit Tax

Chilean copper producers were threatened with added taxation in a proposed measure aimed at raising funds for reconstruction in the earthquake zone. The Chamber of Deputies approved a measure on March 8 that provided for a graduated tax on copper exports. The bill was scheduled to come before the Senate on March 14, but action was postponed for reconsideration of the measure.

The tax proposed by the lower house follows:

"(a) That part of the price up to 6c. of a United States dollar a pound will be tax free;

"(b) That part of the price which exceeds 6c. and up to 10c. a pound will pay 15 per cent;

"(c) That part of the price which exceeds 10c. and up to 15c. a pound will pay 20 per cent, and

"(d) That part of the price which exceeds 15c. a pound will pay 30 per cent."

The tax was to be based on the world price as quoted in the New York market for electrolytic copper, using the previous month's average quotation for foreign copper.

On March 29, however, word was received that the Senate had agreed on a 10 per cent tax on profits instead of the original plan to impose an export tax on copper. The Chamber of Deputies and the President will have to act on the bill before it becomes law.

Big Savings
. . . IN HANDLING MATERIALS

MINING men and excavating engineers all over the world have proved the economy of Sauerman Drag Scrapers, Slackline Cableways, and Tower Excavators on long haul work of every description, including open pit mining, river dredging, rehandling, tailings, ore and coal storage, building earth dams, cleaning settling ponds, etc.

It is easy to see why a Sauerman machine handles materials on long hauls at a lower cost than can be attained by any other method of handling. A Sauerman machine spans the pit, pond, bank or storage pile and digs, conveys and dumps in a continuous cycle of operation, under complete control of one operator.

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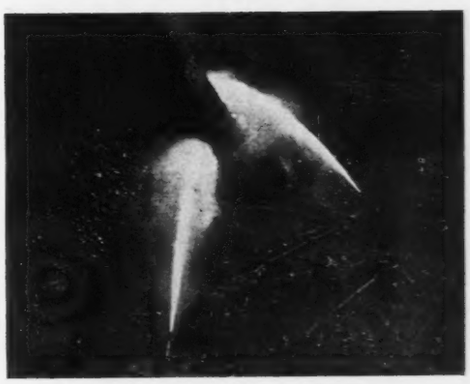

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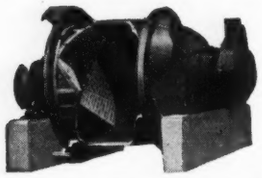

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AFRICA

Large Sums Spent for Mine Ventilation

Advance reported in improving health of workers employed in deep mines—Negotiations under way for merger of two tin producers in Nigeria

▶ The Witwatersrand gold production was slightly smaller in February, due to the fewer working days, and this and the lower average price of gold, 148s. per ounce against 148s. 6d. the previous month, caused a slight recession in earnings. Two of the newer producing companies, Van Dyk and Grootvlei, reported high record profits. At this writing the mining interests are expecting that taxation will remain unchanged for a further year. John A. Agnew, who has recently returned to London from a visit to Africa, says that the amount of research being continually carried out by Witwatersrand companies to improve the health and safety of miners and on general technical lines is prodigious. Large amounts are being spent to improve ventilation in the deep mines. "Altogether," he is quoted as saying, "I am greatly impressed with the advances made and the very healthy state of the industry on the Witwatersrand."

▶ Drilling in the far western Witwatersrand is being continued energetically by several companies, and the geological information being gained promises soon to make tests of the gold reefs a much simpler matter. It is rumored that West Witwatersrand Areas will float another subsidiary, to be called West Driefontein, in the almost immediate future, drilling having proved values which call for development.

▶ Fears which were being expressed till recently of a further reduction of the production quotas of the Rhodesian copper mines appear to have subsided. It is understood that the British government is arranging for large supplies of electrical equipment spare parts, to provide against the possibility of breakdowns in the event of war, and also having a survey of copper supplies made. These activities, together with improving business conditions in most European countries, are expected to increase the consumption of copper immediately. The only thing which would prompt a further reduction of production quotas would be a tendency for stocks to accumulate.

▶ Konongo Gold Mines, of which Robert Annan is chairman, is paying a final dividend of 8½ per cent, making 12½ per cent for the year. This company was formed in 1933 to purchase from Lyndhursts Deep Level Co. the Akyenase gold mine with equipment and buildings, and it promptly started to develop the mine extensively with good results. Its ore reserves are now reported as 464,269 tons averaging 9.42 dwts per ton. A new deep shaft is now being sunk which will be carried to a depth of at least 2,000 feet, and a plan for an increase in milling capacity is receiving favorable consideration. Last year's treatment was 92,018 tons of ore averaging 9.33 dwts. Production was 39,970 ounces of fine gold.

▶ Negotiations are practically completed for the merging of Associated Tin Mines of Nigeria and London Nigerian Tin Mines. The management of the two companies is now the same and the two properties adjoin. Capital in each case is £1,000,000 in 5s. shares, though London Nigerian has only £950,000 issued. A new company, Amalgamated Tin Mines of Nieria (1939), has been formed which is planned to have a capital of £2,000,000 in 5s. shares and these will be offered share for share after Associated Tin has paid a dividend of 7 per cent and London Nigerian a dividend of 3 per cent. It is stated that relative valuations were arrived at by a computation which showed that by working out the entire known tin reserves a profit of £3,121,140 would be realized by Associated Tin and £3,025,864 by London Nigerian, an average price of £200 per ton for tin being assumed. D. Christopherson is chairman of the former company and J. Ivan Spens of the latter. The annual quota of Associated is 4,586 tons, and of London Nigeria 3,400 tons.

▶ The old mining district of Gongong, 34 miles west from Kimberley, has been proclaimed a diamond "diggins" and 473 claims have been pegged.

AUSTRALIA

Lake George Mines Ships First Concentrates

Present rate of production is 500 tons of ore per day—Official Australian gold production in 1938 was 1,590,406 oz.

▶ Official figures for 1938 have just been released, showing that the output was 1,590,406 fine oz., an increase of 209,975 oz. over 1937 and the greatest yield for any year since 1916.

Western Australia

▶ Production on the eastern goldfields of the State showed a notable improvement during 1938, as figures made available recently show. Tonnage treated in the area, which includes the Kalgoorlie field, increased by over 200,000 on the year, and output of gold over 60,000 oz. No new finds of any consequence were reported, the improvement coming mainly from existing producers. Comparisons with previous years are:—

	Tonnage treated	Gold, fine oz.	dwt. per ton	Men employed
1935	936,787	332,800	7.1	5,823
1936	1,163,064	438,375	7.55	6,370
1937	1,298,282	491,741	7.6	6,267
1938	1,529,686	553,720	7.2	6,293

A new gold find is reported from a point 230 miles north of Kalgoorlie. The reef is stated to have been traced for a length of three-quarters of a mile on the surface, and to carry values up to one ounce per ton.

▶ Triton Gold Mines N.L., Reedy, in diamond drilling on the adjacent Rand

leases of Western Gold Mines N.L. (which it is developing on a cost-and-profit-sharing basis) has encountered oxidised ore at a vertical depth of 180 ft., assaying 9.7 dwt per ton over a bore length of 38 ft.

Victoria

▶ Wattle Gully Gold Mines N.L., Chewton, earned a net profit of £20,878 Aust. for the six months to December 31, from the treatment of 9.762 tons of ore, which yielded 4,146 oz. gold, 952 fine, exclusive of gold in concentrates, which yielded another 9/- per ton ore. The ore reserve position is strong, main production at present coming from the 575-ft. and 655-ft. levels, but the mine has been opened up to 800 ft. and a winze below that level. Enlargement of the battery from 20 to 30 head of stamps, which should increase throughput to about 600 tons weekly is in progress.

▶ Cocks Pioneer Gold & Tin Mines, Eldorado, which has spent the last few months in opening-out operations, has now reached bedrock, and sluicing should proceed along routine lines from now on.

New South Wales

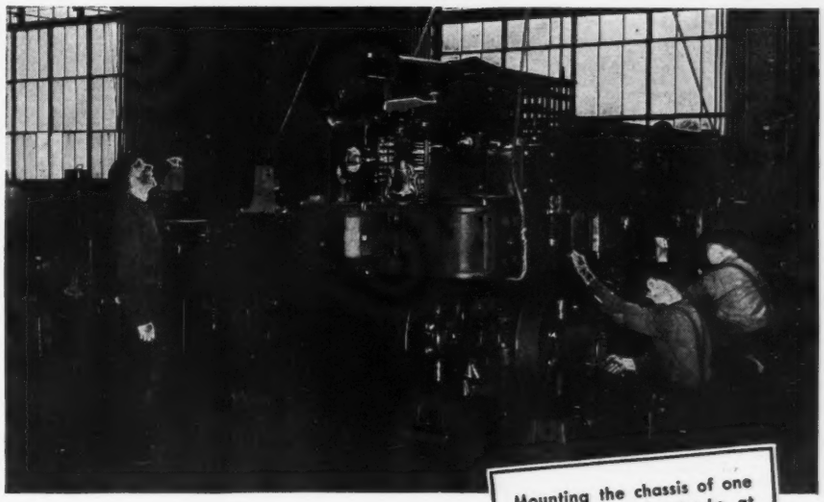
▶ Working profit of New Occidental Gold Mines N.L., Cobar, the leading gold-mining company of the State, was £138,716 Aust. for the year to Nov. 30, 1938, an increase of £38,405 over the figure for 1937. The company operates two mines—the New Occidental and the New Cobar. The former yielded 95,657 tons of ore from which 31,359 oz. of gold were recovered by cyanidation. At the latter mine, where the ore is cupriferous, flotation is practised, 45,045 tons of ore being treated for 4,604 tons of concentrate containing 609 tons copper and 13,230 oz. gold. Working costs were, respectively, 35/7 (Aust.) and 40/6 (Aust.) per ton ore. Proved and probable ore reserves are 714,000 tons, assaying approximately 8 dwt. per ton, in the New Occidental mine, and 249,000 tons, averaging 7.0 dwt. gold and 1.3 per cent copper, in the New Cobar. C. E. Blackett is general manager.

▶ Underground operations at the Proprietary Mine, Broken Hill, ceased on March 4. It was originally intended to close down before the end of 1938.

▶ First concentrates from the mine of Lake George Mines Ltd., Captain's Flat, have been sent to Port Kambla for shipment to America. The mine is equipped with a plant to treat 500 tons of ore daily, but designed to be extended to 1,000 tons at relatively small expense. Capital expenditure has been in the vicinity of £1,000,000. The ore is a fine grained mixture of galena, blende and pyrite carrying about 7.5 per cent lead, 13 per cent zinc, 2.0 oz. silver and 1.5 dwt. gold per ton.

▶ Mt. Morgan Ltd. has completed the erection of its new copper smelting and converting plant, and of the powerhouse and sulphide mill extensions. The latter, which went into operation on Jan. 18, are designed to enable the treatment of 10,500 tons of sulphide ore weekly. First calcines were produced from the Edwards roaster on Jan. 14, and charging of concentrates to the reverberatory furnace commenced February 1.

We're Shipping These Two Locomotives 11,000 Miles



Mounting the chassis of one locomotive on its trucks at our Erie Works. The other is completely assembled

. . . and Here's Why They'll Stay on the Job

THESE two 8-ton, trolley-type G-E locomotives go to Northern Rhodesia, South Africa, where the Mufilira Copper Mines, Ltd., will use them for hauling copper ore. A dozen similar G-E locomotives operate in this immediate area.

They're built to last. Note the thick, rolled-steel side frames and the extra-sturdy, all-steel end frames. Special protection is provided against extremely wet conditions. The double-spring equalized suspension (pioneered by General Electric) improves riding qualities and helps prevent derailment.

Should a major repair be needed, Mufilira can contact General Electric representatives in Johannesburg, South Africa, where skilled service men and a warehouse of G-E parts are available—part of our world-wide service organization.

DATA

Weight—8 tons
Drawbar pull—4000 lb
Voltage—250 volts, d-c
Track gage—30 in.
Wheelbase—60 in.
Length—164 in. over knuckles
Height—60 in. above rail (over trolley base)
Width—54 in.

Representatives will be glad to tell you of the many features of G-E mine locomotives which contribute to their reliability and long life. Contact the nearest G-E office. General Electric Company, Schenectady, N. Y.

BUILDER OF MINE LOCOMOTIVES SINCE 1887

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NEW BOOKS

SILVER MONEY. *By Dickson H. Leavens. Sponsored by the Cowles Commission for Research in Economics. (Monograph No. 4). For sale by Principia Press, Inc., Bloomington, Ind. Pp. 439. Price, $4.00.*

COMMENT upon this notable work will be found on pages 27 and 28 of this issue. The subject is dealt with in 31 chapters, supplemented by a lengthy appendix. Of major interest here is the author himself. It is natural to want to know with what authority he writes. Mr. Leavens was a member of the faculty of the College of Yale in China, Changsha, from 1909 to 1928, serving as treasurer during the last 12 years of that period. From 1929 to 1933 he was on the research staff of the Harvard Graduate School of Business Administration. In 1934 he served in India and China as a special agent of the United States Treasury Department. Since 1936 he has been a research associate of the Cowles Commission and managing editor of *Econometrica*. It was in China that his interest in silver began, the fluctuations in its price being an important practical problem in his daily work.

SAMPLING AND ANALYSIS OF CARBON AND ALLOY STEELS. *By the chemists of the subsidiary companies of the United States Steel Corporation. Reinhold Publishing Corporation, New York. Pp. 356. Price $4.50.*

NO BETTER authorities could collaborate on this subject than the chemists of the world's greatest steel company. Two earlier booklets have been published by them, and the current volume is a complete revision of methods as of 1937. The book represents two years' cooperative effort of a committee of chemists and should be a welcome addition to the library of all who have to sample and analyze modern steels. Qualitative and quick tests for identifying various types of steel fill a need that arises from the great variety of alloy steels on the market. Quantitative methods are given for the rare as well as the common constituents of steel.

THE FINANCIAL POST SURVEY OF MINES 1938-39. *The Maclean Publishing Company, Ltd., Montreal and Toronto, Canada. Pp. 316. Price $2.*

FOLLOWING the excellent plan of earlier volumes, this thirteenth annual survey of Canadian mines contains complete and authoritative statements regarding the organization, location, and operations of more than 2,100 mining companies. Individual units are arranged alphabetically and grouped by provinces and mining areas. Statistics of the industry are presented by provinces and for the Dominion as a whole. A special section contains maps of the leading mining districts.

LAKE SUPERIOR IRON ORES, 1938. *Compiled and published by the Lake Superior Iron Ore Association, Hanna Building, Cleveland, Ohio. Pp. 412, including twelve double-page maps. Page size 11x17 in. Price $5. Delivery charges prepaid in United States.*

THIS new handbook on the Lake Superior Iron Country is a notable production. Patterned somewhat after Crowell and Murray's long well-known "Iron Ores of Lake Superior," it surpasses that earlier volume chiefly by virtue of its greater page size, 11x17 in., which permits the presentation of the data on mines in easily readable form and the inclusion of double-page maps of the iron districts drawn on a conveniently large scale.

The book may be divided into two parts, pages 11 to 84 inclusive being devoted to articles dealing with the history, geology, and technical practice of the iron ranges, and the remainder of the book being given over to the directory of mining companies and of the individual iron mines. The latter are grouped alphabetically for each range, with tables of individual mine shipments by years. If desired, the maps may be had separately and unbound, at $1.50 for the entire set or 20c. apiece. The contents also include a flow map in colors showing the movement of iron ore from sources to consuming districts, and various statistical tables and charts.

FLOTATION PLANT PRACTICE. Third Edition. *By Philip Rabone. Mining Publications, Ltd., Salisbury House, London, E.C. 2, England. Pp. 184. Price 12s. 6d.*

DESPITE the lapse of less than three years since the appearance of the second edition, Mr. Rabone has found it desirable to add new material to various parts of the book, thanks to progress made in applying flotation, particularly in the concentration of certain non-sulphide minerals. He has also rewritten the chapter on reagents, giving attention to the chemical theory of flotation, in so far as investigators can agree about it.

VERWERTUNG DES WERTLOSEN (UTILIZATION OF WORTHLESS THINGS. *By Claus Ungewitter. Published by Wilhelm Limpert-Verlag, Berlin, S.W. 68, Germany. Pp. 304. Paper cover.*

INVENTIVE GENIUS has converted into important sources of raw materials many things that previously were utilized to little or no extent, such as scrap, second-hand materials, the air of the atmosphere, sea water, peat, dust, and similar substances. The author and his collaborators survey these achievements in the scientific, technical, and economic fields. Of the fifteen chapters, one deals with low-grade mineral raw materials. In succession, it considers the working of low-grade iron ores and other low-grade ore deposits, dumps as sources of metals, the reduction of the loss incidental to preparation, metal recovery from dust and drosses, the utilization of byproduct metals, and kindred topics. The concluding chapter presents an outline for a rational raw-material economy.

PUBLICATIONS

RECEIVED

Association of Consulting Chemists and Chemical Engineers, 50 East 41st St., New York, N. Y. Directory of association members, indicating their qualifications. Fifth Edition, Jan. 1, 1939, sent gratis on application.

The Mint. Annual report of the Director of, fiscal year ended June 30, 1938, including report on production of precious metals during calendar year 1937. Superintendent of Documents, Washington, D. C. Price 50c.

Alaska. Report of the Commissioner of Mines for the biennium ended Dec. 31, 1938. Contains, in addition to the customary review, a list of lode, dredge, and active placer operations in the Territory.

Sampling for Air Impurities. Air Hygiene Foundation of America, Pittsburgh, Pa. Preventive engineering series, Bulletin 2, Part 8. Contains methods of collection, determination, and apparatus for checking dangerous substances commonly found in industrial atmospheres, some of which are pertinent to the mining industry.

Pattern Making. Revised by Ritchie, Monroe, Beese, and Hall. A practical treatise for the pattern maker. Published by American Technical Society. Drexel Ave. at 58th st., Chicago. Pp. 233. Price $2.

Foundry Work. By W. C. Stimpson and B. L. Gray. Revised by John Grennan. A practical handbook on standard foundry practice, published by American Technical Society, Drexel Ave. at 58th st., Chicago, Pp. 216. Price $2.

Analyses of Rocks, Minerals, Ores, Coal, Soils, and Waters From Southern Africa. Compiled by A. L. Hall. Memoir No. 32. Geological Survey, Union of South Africa, Pretoria. Pp. 876. Price 15s.

Silver Mining Industry in Canada, 1937. Summary Review (includes data on production of lead, zinc, arsenic, and cobalt). Dominion Bureau of Statistics, Ottawa. Pp. 29. Price 25c.

Geology and Ore Deposits Near Murray, Idaho. By Philip J. Shenon. Pamphlet 47, Idaho Bureau of Mines and Geology, Moscow, Idaho. Pp. 44.

French West Africa. Report on the Mineral Industry, 1937. By M. P. Seyer, chief of the Service du Mines. Also Bulletin No. 1, containing studies of various mineral deposits in the area. Pages 88, plus numerous plates and maps.

Quebec. Annual Report of Bureau of Mines, 1936. Part B. Covering Simard (Expanse) Lake, Suzor-Letondal, Bruneau Township and vicinity, and Grevet (Kamshigama) map-areas. Quebec, P. Q. Pp. 81, plus maps.

India. Annual Report of Chief Inspector of Mines for India, 1937. Delhi. Pp. 211. Price 3s. 6d.

The San Juan Country. A Geographic and Geologic Reconnaissance of Southeastern Utah. By H. E. Gregory, with contributions by Malcolm Thorpe. U. S. Geological Survey Professional Paper 188. Pp. 123. Sold by Superintendent of Documents, Washington, D. C. Price 60c.

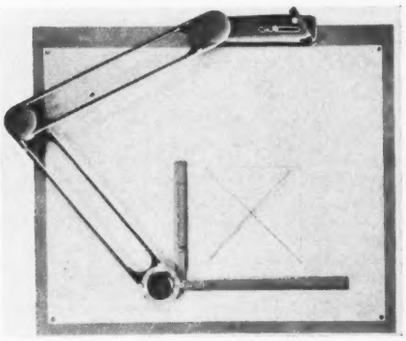
Geology of Muskogee-Porum District, Oklahoma. By C. W. Wilson, Jr., U. S. Geological Survey, with chapter on Carboniferous Stratigraphy, by N. D. Newell, Oklahoma Geological Survey, Norman, Okla. Pp. 184. Also "Traverse and Leveling in Oklahoma," compiled by N. E. Wolfard. Bulletin 58. Oklahoma Geological Survey. Pp. 157.

EQUIPMENT NEWS

Improved Drafting Machine

AN ARM COMPLETELY enclosing bands and working parts constitutes a major improvement in the Model 77 drafting machine now offered by the Universal Drafting Machine Co., Cleveland, Ohio.

Another improvement is the full-vision protractor, located entirely above the arm, giving unrestricted vision and



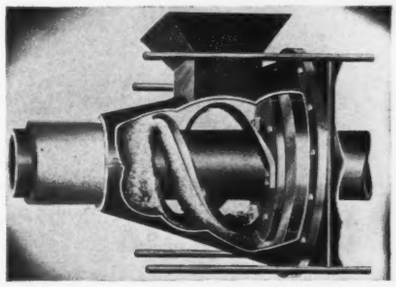
greater convenience of operation and control. A secondary 360 deg. protractor movement has been added, to permit setting of the protractor to any angle on the drawing, such as 7 or 77 deg. Then from the new baseline, the 30, 45, 60 and 90 deg. stops can be used or any graduation read directly. This secondary 360 deg. rotating element is operated by two thumbscrews. Both protractor and arm are said to be light in weight, which affords easier setting of the machine to an exact point. Exceptional accuracy is claimed for the product.

New Oil for Diesels

FOLLOWING EXHAUSTIVE tests the Standard Oil Company of California is announcing its New "RPM" DELO (Diesel Engine Lubricating Oil). Standard Oil engineers are confident that this New "RPM" Diesel Engine Lubricating Oil will bring the maximum service benefits of correct lubrication to all Diesel engines, regardless of size or design. These scientists stress the point that now giant Diesels in power and industrial plants, small high-speed Diesels in trucks and busses, rugged Diesels in tractors and aboard ships can derive full lubrication protection from its proper S.A.E. grade of New "RPM" DELO. To meet all requirements of all Diesels, New "RPM" DELO is said to possess the following important properties as established by exhaustive field and laboratory research: 1—It prevents ring-sticking even under the most severe engine operating conditions. In comparison with other oils it is appreciably superior in the maintenance of piston cleanliness and the prevention of carbon and sludge deposits in oil ring slots. 2—It is non-corrosive to alloy bearings and is, therefore, suitable for use in all engines, regardless of bearing materials. The new oil is recommended for engines employing copper-lead, cadmium-silver, Satco and similar types of bearing materials. 3—It reduces wear of cylinders, pistons and rings. 4—The compounding material used in New "RPM" DELO is a powerful anti-oxidant. Thus this lubricant is highly resistant to oxidation and deterioration. 5—The compounding is stable in the presence of moisture and in storage. 6—Due to its great stability, the oil will reduce filter clogging to the very minimum. 7—This lubricant minimizes cylinder and ring wear in high temperature regions such as the tops of pistons. This is because the oil has unusual capacity to spread and lubricate hot metal surfaces instead of receding and leaving them dry. This vital property may well be described as "high engine film strength." 8—New "RPM" DELO protects all bearing surfaces, piston rings and cylinders during the critical breaking-in period.

Protection for Pipe Lines

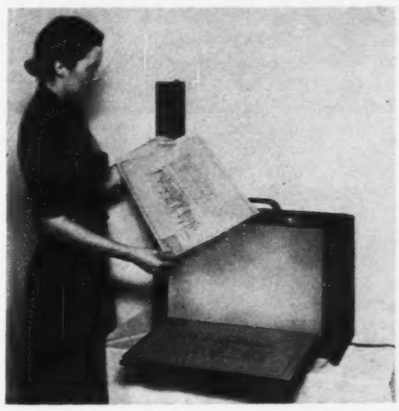
ARMOR-CLAD, a new process of coating pipe with cement or bituminous concrete, has recently been introduced by the American Pipe & Steel Corporation, 230 Date Ave., Alhambra, Calif. This unique method of application, by means



of a specially designed, patented machine, now makes it possible to obtain a continuous, dense, uniform outer jacket which forms a perfect, seamless bond with the pipe. This type of protective covering is intended to be permanently effective. Armor-Clad is based on the theory that any properly prepared material can be made to adhere tightly to pipe if it is submitted to continuous rubbing pressure. However, such plastic materials must be of the proper consistency, similar to that of bituminous and concrete Armor-Clad formulas, to respond to the spiral rubbing, troweling, and tamping action that is the secret of the success of the process. Coatings, after having been submitted to tremendous pressure, are said to be held firmly in position by atmospheric pressure because of the intimate contact of steel and plastic.

Portable Printer

ELECTRONICS PRODUCTS Manufacturing Corporation, Ann Arbor, Mich., announces the Elpro portable printer, said to be housed in a substantially built cabinet, having a gun-metal finish. The unit operates on 110 volt a.c. and is also supplied for direct current. The light source consists of six special lamps totaling 850 watts. The life of the lamps is said to be rated for 100 hours which permits printing of approxi-



mately 5,000 prints. Prints can be made from one to five minutes from tracings, plans, specifications, etc., dry and ready for use. Using Ozalid dry process paper a white background and blue lines is obtained. Printing size is 12 in. x 18 in. The developer consists of a metal cylinder with ammonia container at the bottom. The top cap is removable for inserting prints to be developed.

Car Spotter

FOR QUICKLY SPOTTING railroad cars for loading or unloading, Link-Belt Company, Chicago, Ill., announces that it has developed a line of two new vertical-capstan electric car spotters, designated as No. 5-A and No. 10-A, respectively capable of 5000 lbs. rope pull or moving one to three cars, and 10,000 lbs. rope pull or capacity to move three to six cars, depending upon track conditions, whether level, on grade, straight or curved. The new machines employ a high torque electric motor of user's choice, connected to spotter drive mechanism by an encased flexible roller chain coupling, and mounted, with the spotter, on a welded steel base plate.

Corrosion Resistant Bearings

BANTAM BEARINGS CORPORATION of South Bend, Indiana, has announced production of ball and roller bearings made of "K" Monel in all required sizes and types for use in services involving exposure to corrosive liquids and gases. This nickel-copper alloy can be heat-treated to provide a hardness, wear-

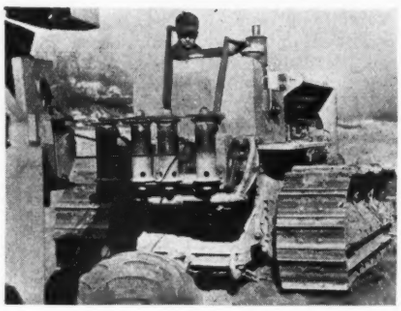
resistance and strength not ordinarily associated with non-ferrous bearing materials. Its resistance to corrosion is said to be such that it can withstand the action of many acids, most alkalies and a wide range of gases. Furthermore, it retains high mechanical properties over a range from low sub-zero temperatures to above 800° F. It is non-magnetic down to —110 deg. F.

New Inkless Recording Instruments

CONTINUOUS accurate operation for 30 days without attention, at temperatures as low as —10 F. and as high as 120 F., is made possible by the new Type CF-1 line of inkless recording single- and double-range a-c ammeters and voltmeters just announced by the General Electric Company, Schenectady, N. Y. The units are in the low-price range and are particularly well suited for voltage surveys, complaint investigations, and checking circuit load conditions. The inkless mechanism, which uses a typewriter ribbon, to make the record by a series of dots, results in greater simplicity, small size and light weight. There is no inkwell to clean, no pen to start, and nothing to freeze in cold weather. A cast-aluminum alloy case of modernistic design protects the mechanism and further suits the new instruments for service while exposed to the weather. Although they are portable, the new instruments may be wall- or pole-mounted.

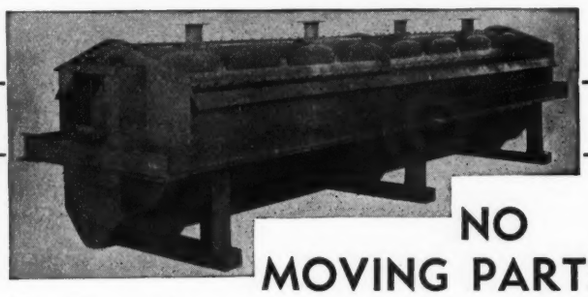
Gasoline Power Unit

ALLIS-CHALMERS MANUFACTURING Company of Milwaukee, Wis., has announced the addition of a new Model "B-15" to their line of gasoline power units. The unit is a 4 cycle, 4 cylinder gasoline engine with a bore of 3¼ inches, a stroke of 3½ inches and 116 cubic inch displacement. The "B-15" is said to develop a maximum of 10 brake horsepower at its normal governed speed of 1400 R.P.M. At 1800 R.P.M. it develops 22 brake horsepower maximum. Its maximum torque is 74 lbs. ft. developed at 1100 R.P.M. This new unit measures only 31 1/16 inches high, 17⅝ inches wide and the length including starting crank is 52¾ inches.



To facilitate the handling of cable-controlled scrapers, bulldozers and other equipment, Caterpillar Tractor Co., Peoria, Ill., has announced this new cable control attachment for its track-type tractors.

SOUTHWESTERN AIR FLOTATION MACHINE



NO MOVING PARTS

To Corrode . . .

Clogging or fouling of mechanical parts through contact with sandy, chemically effective wet pulp mass is impossible. Southwestern has no moving parts within the machine or mechanical parts exposed to corrosion. It is all-steel or redwood construction with parts subject to wear reinforced with sheet rubber. This efficient simplicity makes possible uninterrupted operation at peak tonnage capacity with lower maintenance and reduced supervision. Write for descriptive Bulletin No. 1280.

Consult Southwestern. Twenty-five years successful experience in serving the mining industry throughout the world is at your command.

SOUTHWESTERN ENGINEERING CO.

4800 Santa Fe Avenue — Los Angeles, California

BULLETINS

Gear Motors. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet 2203-B presents line drawings and installation photographs showing gear motor applications. Pp. 3.

Jaw Crushers. The Eimco Corporation, Salt Lake City, Utah. Bulletin 305 describes and illustrates the manufacturer's new line of jaw crushers. Pp. 4.

Ball Mills. Denver Equipment Co., Denver, Colo. Bulletin 38B2 describes and illustrates the manufacturer's five types of ball mills and accessory equipment for ore grinding. A feature of the bulletin is an attached circular slide rule that determines size of ball mill to grind tons of ore to desired mesh. Pp. 26.

Ground Rods. Anaconda Wire & Cable Company, 25 Broadway, New York. Anaconda Publication C-14 describes and illustrates features and uses for contacts to the manufacturer's Star ground rod. Pp. 18.

Screw Threads. Air Associates, Inc., 5300 West 63d St., Chicago, Ill. Manufacturer describes and illustrates the Aero-Thread Screw System that permits use of steel screws in soft metal. Pp. 7.

Tractor. Caterpillar Tractor Co., Peoria, Ill. Bulletin Form 5033 describes the new R-2 tractor for general use with 25.5 drawbar horsepower. Pp. 11.

Metal for Pump Castings. Meechanite Metal Corporation, Vandergrift Building, Pittsburgh, Pa. Booklet 100 describes and illustrates various adaptions of Meehanite to pumps with severe service requirements. Pp. 6.

Synchronous Motors. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Booklet B-2164 describes in simple language the proper selection of synchronous motors for various industrial uses. Pp. 11.

Portable Pipe and Bolt Machine. Beever Pipe Tools, Inc., Warren, Ohio. Bulletin C describes and illustrates a compact portable power unit for pipefitting. Pp. 4.

Geared Drives. Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa. Bulletin B 2159 describes and illustrates gear drives for various industrial uses. Pp. 35.

Expansion Joints. Foster Wheeler Corp., 165 Broadway, New York. Bulletin X-39-5 describes construction details of the manufacturer's Type "S" stainless-steel bellows packless expansion joint. Pp. 4.

Electrical Cables for Mining Use. Hazard Insulated Wire Works, Wilkes-Barre, Pa. Catalog illustrates and describes insulated wire products for use in mining industry. Pp. 48.

NEMA Standards and Definitions. Louis Allis Co., Milwaukee, Wis., has prepared this booklet for reference about electric motors. Pp. 8.

Condenser Tube Upkeep. Condenser Service & Engineering Co., Inc., Hoboken, N. J. Folder describes the manufacturer's "air and erosion eliminator." Pp. 4.

Steam Turbines. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Bulletin 2175 describes and illustrates by photograph and drawing specifications of turbines from 100 to 2,000 h.p. and the manufacturer's types of turbines for various industries using mechanical and electrical power. Pp. 22.

Voice-Powered Telephone. Telfair Telfone Corp., 52 Standish Ave., West Orange, N. J. Folder describes use of voice-powered telephone without batteries or electrical current. Pp. 4.

Cable, Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. Folder describes manufacturer's Sunex Securityflex, a corrosive and heat-resisting two-conductor type cable for mine use. Pp. 4.

Stokers. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Bulletin 2170 describes and illustrates single- and multiple-retort stokers for bituminous-coal burning requirements. Pp. 19.

Lathe. Sheldon Machine Co., Inc., Chicago, Ill. Folder describes and illustrates the manufacturer's new lathe for small shops, tool rooms, garages, and home craftsmen. Pp. 4.

Crane Research Laboratories is the name of a handsomely illustrated brochure by the Crane Co., 836 South Michigan Ave., Chicago, Ill. Chapters cover metallurgy, welding, radiographs, industrial products, ceramics, sanitation and hydrau-

lics, heating and air conditioning, and other phases of the company's research on valves, fittings, pumps, plumbing, and heating equipment. Pp. 47.

Semi-Portable Air Compressor. Sullivan Machinery Co., Michigan City, Ind. Catalog WN-102 describes the manufacturer's three new semi-portable air compressors.

Metal-Cutting Blanks. McKenna Metals Co., 127 Lloyd Ave., Latrobe, Pa. Catalog 2 describes specifications and illustrates metal-cutting blanks of Kennametal.

Controlling Instruments. Brown Instrument Co., Philadelphia, Pa. Folder G-37 illustrates the manufacturer's general line of indicating, recording, and controlling instruments. Pp. 8.

Water-Gage Illuminator. Wright Austin Co., 315 W. Woodbridge St., Detroit, Mich. Circular 505 describes a neon water-gage illuminator. Pp. 4.

Flexible Metal Hose. Flexible Metal Hose & Tubing Institute, 150 Broadway, New York, N. Y., announces a new booklet entitled "The Fact Book of Flexible Metal Hose and Tubing." Pp. 19.

Vibrating Screen. Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1478 B describes and illustrates the manufacturer's complete line of single-, double-, and triple-deck compact units. Pp. 12.

Magnetic Switches. Denver Equipment Co., Denver, Colo. Leaflet 38M8A describes the CR7006 general-purpose magnetic switch. Pp. 1.

Variable-Speed Transmission. Ideal Commutator Dresser Co., 1236 Park Ave., Sycamore, Ill. Form BR 938 describes the manufacturer's "Select-O-Speed" transmission, attachable to old and new machinery. Pp. 16

Diesels. Venn-Severin Machine Co., 1317-1327 West North Ave., Chicago, Ill. Bulletin 455, describes and illustrates the manufacturers' Model M diesel-type engine. Pp. 23.

Stoper. Sullivan Machinery Co., Michigan City, Ind. Bulletin SS10 describes features of the company's new Safe-T-Stoper, that is self-supporting and can be used for horizontal as well as vertical holes. Pp. 9.

Tractor Trucks. Walter Motor Truck Co., 1001-19 Irving Ave., Ridgewood, Queens, Long Island, N. Y. Bulletin T-50 illustrates and describes tractor truck for all heavy hauling. Pp. 8.

INDUSTRIAL NOTES

Crucible Steel Company of America announces the recent appointment of W. E. Gardner as manager of the Boston branch, 135 Binney St., Cambridge, Mass., succeeding W. P. Knecht, who has been appointed manager of the London, England, office, 9-21 Shand St., S.E.1. The company also announces the appointment of two distributors of its tool and machinery steels: Quality Steels Company, of Dayton, Ohio, and Pittsburgh Gage & Supply Company, Pittsburgh, Pa.

Frank J. Hill, for some years Eastern sales representative of Greene, Tweed & Company, New York, N. Y., has been made sales manager of the domestic division of the corporation's packing department.

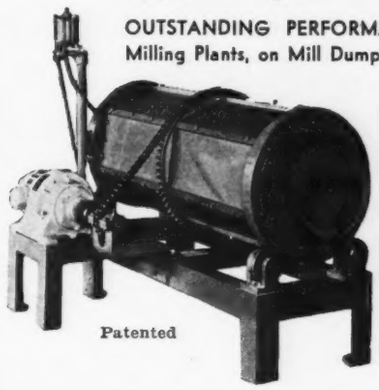
C. Donald Dallas, president of Revere Copper & Brass Incorporated, has announced the appointment of Louis J. Calbreath as technical adviser for the New York district sales division, with headquarters at 75 East 45th St., New York City.

The Roller-Smith Company announces the consolidation, as of Feb. 1, 1939, of its executive offices (located prior to Feb. 1 in New York City) with its works at Bethlehem, Pa. After Feb. 1 all activities of the company will be concentrated at the new headquarters at Bethlehem, Pa.

THE TITAN ROTARY AMALGAMATOR

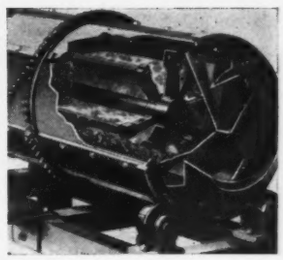
HIGH RECOVERY OF FREE GOLD. Recovers finest flour gold also dirty, rusty or coated gold.

OUTSTANDING PERFORMANCE. Installations of highest efficiency in Milling Plants, on Mill Dumps and in Dredging and other placer operations.



Patented

RIGHT — In flowing through the Amalgamator material is brought against the plates, in a series of direct impacts, many times before discharge.



QUICKLY CLEANED. Core can be removed, plates cleaned and core replaced ready for operation in 32 minutes. Or core withdrawn and replaced by spare core ready to run in 8 minutes.

Users Report: Cost of Maintenance is very Low! As High as 98% Recovery!

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Contain the names and addresses of every manufacturer whose products are of major importance in metal and non-metallic mining.

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For 16 years the standard buyers' guide for the men who specify and buy at the mines.

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GEMCO TRU-BLU RAIL BENDERS

Reduce Mining Costs

What does it cost you to bend and straighten rail? These benders will save up to 50% of the cost over old methods on all rail from 8 to 120 lb. sizes! Write us for proof of how you can cut your production costs by using all items in the "Gibraltar" line of mining tools: Standard and Ratchet type Rail Punches and Rail Benders; Spike Bars; Mine Cars for Track Layers, Drillers, Shot Firers, Supplies, Trouble Shooting, and "Hot Shot" Inspection Trips; Car Stops; Rerailers; Derailers; Mine Ambulances; Keyseaters; Grease Guns; etc.

RATCHET TYPE

Profitable franchises still open for live jobbers—Domestic and Export. We solicit inquiries from equipment importers.

"Gemco Tru-Blu" Tools give Savings with Safety! Write us for complete data and catalog—or buy from jobber's stock.

GIBRALTAR EQUIPMENT & MFG. COMPANY

Madison at Fourteenth Street St. Louis, Missouri, U. S. A.

How SLY GIVES YOU BETTER DUST CONTROL

Sly filter cloth—flameproofed where static electricity and sparks are encountered—has over 1,000,000 apertures per square foot. These apertures assure a minimum of resistance to air flow. Each one of the apertures is formed of fibrous threads which effectively entrain the dust particles carried by the dust-laden air passing through the bags.

★ For *thorough* dust removal, the dust-laden air must be "filtered", i.e., passed through a medium which permits the passage of air but *not* dust, (like filtering liquids in the laboratory).

In doing this the Sly Dust Collecting System uses a flat *special* cloth bag made of long fibre cotton, which cleans the air thoroughly of the fine, injurious dust.

This is an exclusive Sly Feature. This high degree of filtering efficiency is difficult or even impossible to attain where dust is collected by other methods such as centrifugal force or washing.

Sly Dust Filters are very simple in design, easily installed and economical in space and power. Sly Dust Control is *not* expensive.

Tell us your dust problem and one of our engineers will make an analysis and advise you what can be done about it — no obligation. A valuable bulletin E-90, "Dust Control" is free upon request.

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Pioneers in Dust Control
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DUST CONTROL EQUIPMENT FOR EVERY INDUSTRIAL PURPOSE